Naval Oceanographic and
Atmospheric Research Laboratory

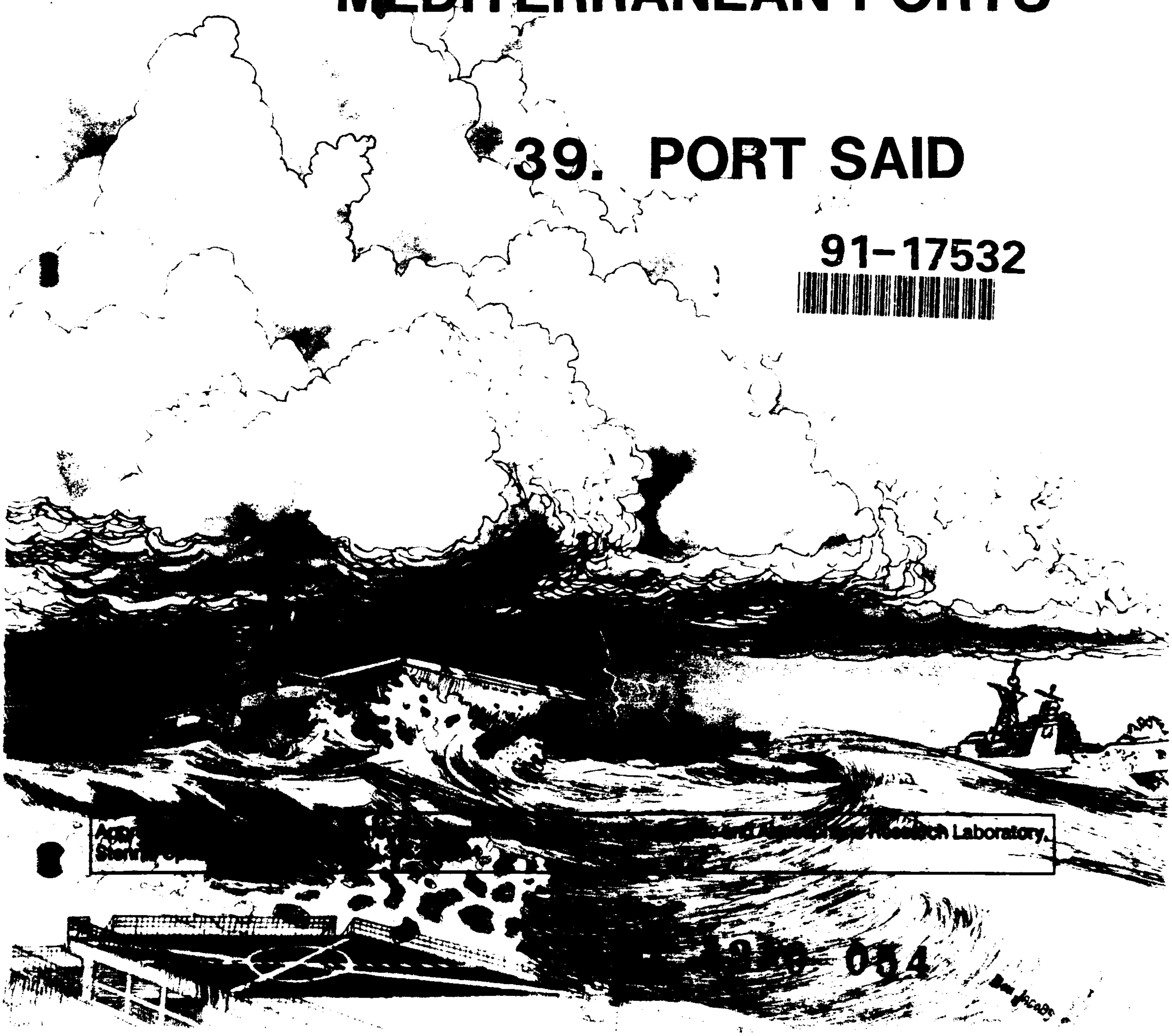
Technical Note 115
June 1991

AD-A243 450

SEVERE WEATHER GUIDE
MEDITERRANEAN PORTS

39. PORT SAID

91-17532



ABSTRACT

This handbook for the port of Port Said, Egypt, one in a series of severe weather guides for Mediterranean ports, provides decision-making guidance for ship captains whose vessels are threatened by actual or forecast strong winds, high seas, restricted visibility or thunderstorms in the port vicinity. Causes and effects of such hazardous conditions are discussed. Precautionary or evasive actions are suggested for various vessel situations. The handbook is organized in four sections for ready reference: general guidance on handbook content and use; a quick-look captain's summary; a more detailed review of general information on environmental conditions; and an appendix that provides oceanographic information.

ACKNOWLEDGMENTS

The support of the sponsors - Naval Oceanography Command, Stennis Space Center, MS: and Fleet Numerical Oceanography Center, Monterey, CA (Program Element O&M,N) - is gratefully acknowledged.

CONTENTS

FOREWORD

This handbook on Mediterranean Ports was developed as part of an ongoing effort at the Atmospheric Directorate, Naval Oceanographic and Atmospheric Laboratory (NOARL), Monterey, to create products for direct application to Fleet Operations. The research was conducted in response to Commander Naval Oceanography Command (COMNAVOCEANCOM) requirements validated by the Chief of Naval Operations (OP-096).

As mentioned in the preface, the Mediterranean region is unique in that several areas exist where local winds can cause dangerous operating conditions. This handbook will provide the ship's captain with assistance in making decisions regarding the disposition of his ship when heavy winds and seas are encountered or forecast at various port locations.

Readers are urged to submit comments, suggestions for changes, deletions and/or additions to Naval Oceanography Command Center (NAVOCEANCOMCEN), Rota with a copy to the oceanographer, COMSIXTHFLT. They will then be passed on to NOARL, Monterey for review and incorporation as appropriate. This document will be a dynamic one, changing and improving as more and better information is obtained.

PORT INDEX

The following is a tentative prioritized list of Mediterranean Ports to be evaluated during the five-year period 1988-92, with ports grouped by expected year of the port study's publication. This list is subject to change as dictated by circumstances and periodic review. Computerized versions of these port guides are available for those ports with an asterisk (*). Contact the Atmospheric Directorate, NOARL, Monterey or NOCC Rota for IBM compatable floppy disk copies.

NO.	PORT
*1	GAETA, ITALY
*2	NAPLES, ITALY
*3	CATANIA, ITALY
*4	AUGUSTA BAY, ITALY
*5	CAGLIARI, ITALY
*6	LA MADDALENA, ITALY
7	MARSEILLE, FRANCE
8	TOULON, FRANCE
9	VILLEFRANCHE, FRANCE
10	MALAGA, SPAIN
11	NICE, FRANCE
12	CANNES, FRANCE
13	MONACO
14	ASHDOD, ISRAEL
15	HAIFA, ISRAEL
16	BARCELONA, SPAIN
17	PALMA, SPAIN
18	IBIZA, SPAIN
19	POLLENSA BAY, SPAIN
20	LIVORNO, ITALY
21	LA SPEZIA, ITALY
22	VENICE, ITALY
23	TRIESTE, ITALY
*24	CARTAGENA, SPAIN
*25	VALENCIA, SPAIN
*26	SAN REMO, ITALY
*27	GENOA, ITALY
*28	PORTO TORRES, ITALY
*29	PALERMO, ITALY
*30	MESSINA, ITALY
*31	TAORMINA, ITALY

1991	PORT
*32	TARANTO, ITALY
*33	TANGIER, MOROCCO
*34	BENIDORM, SPAIN
*35	ROTA, SPAIN
*36	LIMASSOL, CYPRUS
*37	LARNACA, CYPRUS
*38	ALEXANDRIA, EGYPT
*39	PORT SAID, EGYPT
40	BIZERTE, TUNISIA
41	TUNIS, TUNISIA
42	SOUSSE, TUNISIA
43	SFAX, TUNISIA
44	SOUDA BAY, CRETE
	VALETTA, MALTA
	PIRAEUS, GREECE

1992	PORT
	KALAMATA, GREECE
	CORFU, GREECE
	KITHIRA, GREECE
	THESSALONIKI, GREECE

DELAYED INDEFINITELY
ALGIERS, ALGERIA
ISKENDERUN, TURKEY
IZMIR, TURKEY
ISTANBUL, TURKEY
ANTALYA, TURKEY
GOLCUK, TURKEY

PREFACE

Environmental phenomena such as strong winds, high waves, restrictions to visibility and thunderstorms can be hazardous to critical Fleet operations. The cause and effect of several of these phenomena are unique to the Mediterranean region and some prior knowledge of their characteristics would be helpful to ship's captains. The intent of this publication is to provide guidance to the captains for assistance in decision making.

The Mediterranean Sea region is an area where complicated topographical features influence weather patterns. Katabatic winds will flow through restricted mountain gaps or valleys and, as a result of the venturi effect, strengthen to storm intensity in a short period of time. As these winds exit and flow over port regions and coastal areas, anchored ships with large 'sail areas' may be blown aground. Also, hazardous sea state conditions are created, posing a danger for small boats ferrying personnel to and from port. At the same time, adjacent areas may be relatively calm. A glance at current weather charts may not always reveal the causes for these local effects which vary drastically from point to point.

Because of the irregular coast line and numerous islands in the Mediterranean, swell can be refracted around such barriers and come from directions which vary greatly with the wind. Anchored ships may experience winds and seas from one direction and swell from a different direction. These conditions can be extremely hazardous for tendered vessels. Moderate to heavy swell may also propagate outward in advance of a storm resulting in uncomfortable and sometimes dangerous conditions, especially during tending, refueling and boating operations.

This handbook addresses the various weather conditions, their local cause and effect and suggests some evasive action to be taken if necessary. Most of the major ports in the Mediterranean will be covered in the handbook. A priority list, established by the Sixth Fleet, exists for the port studies conducted and this list will be followed as closely as possible in terms of scheduling publications.

RECORD OF CHANGES

CHANGE NUMBER	DATE OF CHANGE	DATE ENTERED	PAGE NUMBER	ENTERED BY

1. GENERAL GUIDANCE

1.1 DESIGN

This handbook is designed to provide ship captains with a ready reference on hazardous weather and wave conditions in selected Mediterranean harbors. Section 2, the captain's summary, is an abbreviated version of section 3, the general information section intended for staff planners and meteorologists. Once section 3 has been read, it is not necessary to read section 2.

1.1.1 Objectives

The basic objective is to provide ship captains with a concise reference of hazards to ship activities that are caused by environmental conditions in various Mediterranean harbors, and to offer suggestions for precautionary and/or evasive actions. A secondary objective is to provide adequate background information on such hazards so that operational forecasters, or other interested parties, can quickly gain the local knowledge that is necessary to ensure high quality forecasts.

1.1.2 Approach

Information on harbor conditions and hazards was accumulated in the following manner:

A. A literature search for reference material was performed.
B. Cruise reports were reviewed.
C. Navy personnel with current or previous area experience were interviewed.
D. A preliminary report was developed which included questions on various local conditions in specific harbors.
E. Port/harbor visits were made by NOARLW personnel; considerable information was obtained through interviews with local pilots, tug masters, etc; and local reference material was obtained.
F. The cumulative information was reviewed, combined, and condensed for harbor studies.

1.1.3 Organization

The Handbook contains two sections for each harbor. The first section summarizes harbor conditions and is intended for use as a quick reference by ship captains, navigators, inport/at sea OOD's, and other interested personnel. This section contains:

A. a brief narrative summary of environmental hazards,

B. a table display of vessel location/situation, potential environmental hazard, effect-precautionary/evasion actions, and advance indicators of potential environmental hazards,

C. local wind wave conditions, and

D. tables depicting the wave conditions resulting from propagation of deep water swell into the harbor.

The swell propagation information includes percent occurrence, average duration, and the period of maximum wave energy within height ranges of greater than 3.3 feet and greater than 6.6 feet. The details on the generation of sea and swell information are provided in Appendix A.

The second section contains additional details and background information on seasonal hazardous conditions. This section is directed to personnel who have a need for additional insights on environmental hazards and related weather events.

1.2 CONTENTS OF SPECIFIC HARBOR STUDIES

This handbook specifically addresses potential wind and wave related hazards to ships operating in various Mediterranean ports utilized by the U.S. Navy. It does not contain general purpose climatology and/or comprehensive forecast rules for weather conditions of a more benign nature.

The contents are intended for use in both previsit planning and in situ problem solving by either mariners or environmentalists. Potential hazards related to both weather and waves are addressed. The oceanographic information includes some rather unique information relating to deep water swell propagating into harbor shallow water areas.

Emphasis is placed on the hazards related to wind, wind waves, and the propagation of deep water swell into the harbor areas. Various vessel locations/situations are considered, including moored, nesting, anchored, arriving/departing, and small boat operations. The potential problems and suggested precautionary/evasive actions for various combinations of environmental threats and vessel location/situation are provided. Local indicators of environmental hazards and possible evasion techniques are summarized for various scenarios.

CAUTIONARY NOTE: In September 1985 Hurricane Gloria raked the Norfolk, VA area while several US Navy ships were anchored on the muddy bottom of Chesapeake Bay. One important fact was revealed during this incident: Most all ships frigate size and larger dragged anchor, some more than others, in winds of over 50 knots. As winds and waves increased, ships 'fell into' the wave troughs, BROADSIDE TO THE WIND and become difficult or impossible to control.

This was a rare instance in which several ships of recent design were exposed to the same storm and much effort was put into the documentation of lessons learned. Chief among these was the suggestion to evade at sea rather than remain anchored at port whenever winds of such intensity were forecast.

2. CAPTAIN'S SUMMARY

The Port of Said (31°16'N 32°18'E) is located at the Mediterranean entrance to the Suez Canal (Figure 2-1). The Port is about mid-way between Alexandria, Egypt to the west and Ashdod, Israel to the east-northeast, about 150 nmi from each.

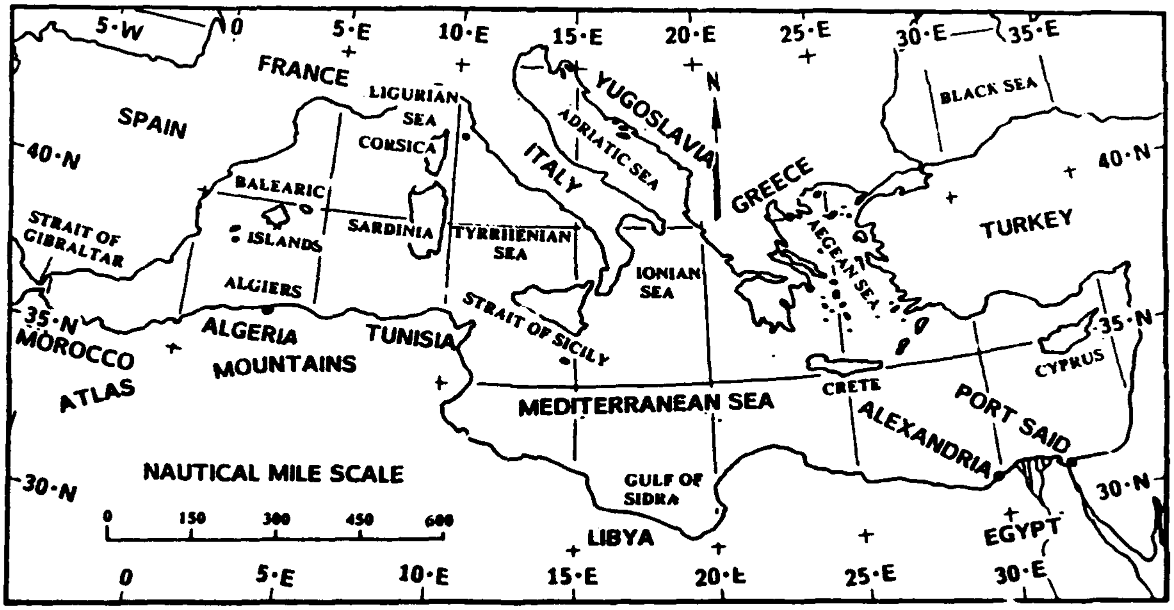


Figure 2-1. Mediterranean Sea.

The Port is situated a couple of miles west of the Port Suez bypass approach channel to the Suez Canal (Figure 2-2). The coastline in this area is unusually low.

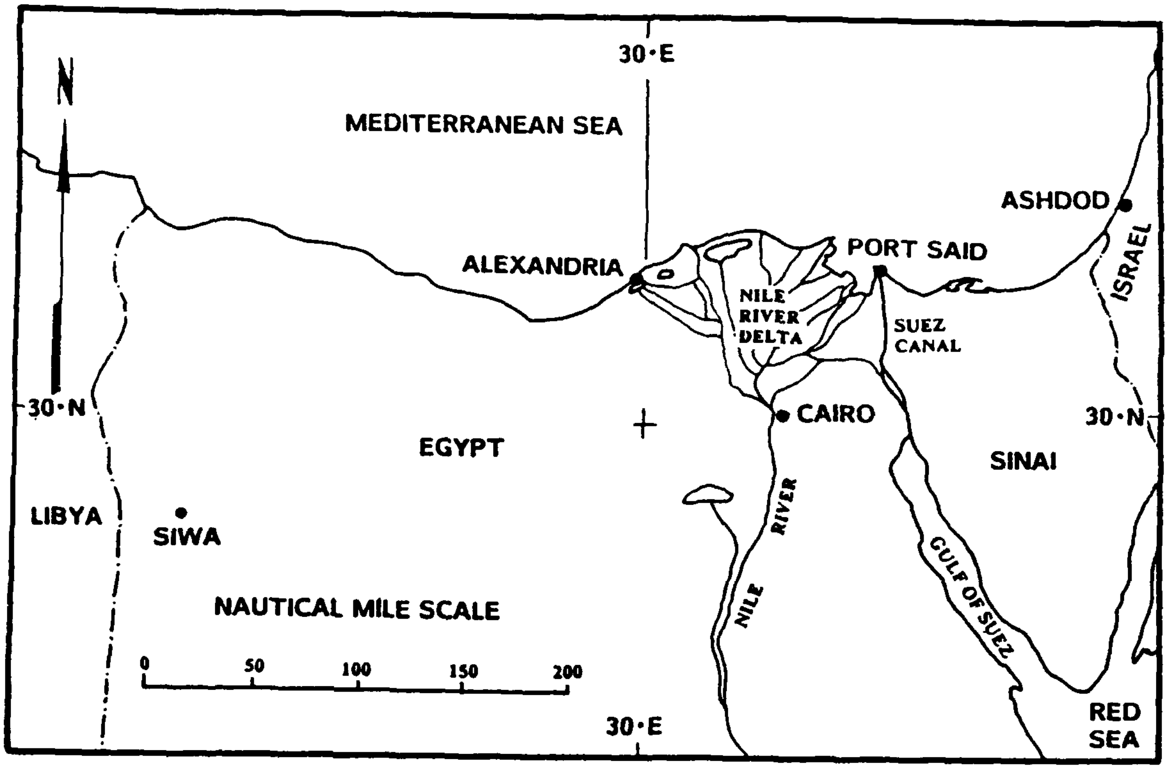


Figure 2-2. Northern Egypt and adjacent waters.

Port Said is an artificial harbor formed by two concrete breakwaters which extend seaward from the low sandy coast. The old approach channel to the Suez Canal forms the channel to Port Said (Figure 2-3). There are two large anchorage areas northwest of the entrance to the Suez Canal and Port Said (Figure 2-4). They are fully exposed to open sea wind and waves. The city of Port Said is on the west side of the harbor, and the large suburb of Port Fouard is on the east side.

Daylight navigation into Port Said is recommended (FICEURLANT, 1987). The approach zones typically hold a large number of anchored vessels, the low coastline provides poor radar return and currents near the seaward end of the breakwater tend to be quite variable. Ships should stay to the windward wide of the channel and should not stop in the channel.

There are a number of basins adjacent to the main canal which contain mooring buoys. The Outer Basin and Ismail Basin provide the deepest draft. Navy vessels typically moor inside the breakwaters. A series of 4 mooring buoys are used to anchor each ship, generally two forward and two aft. There are no pier side berths available to Navy ships and there is no designated Fleet Landing.

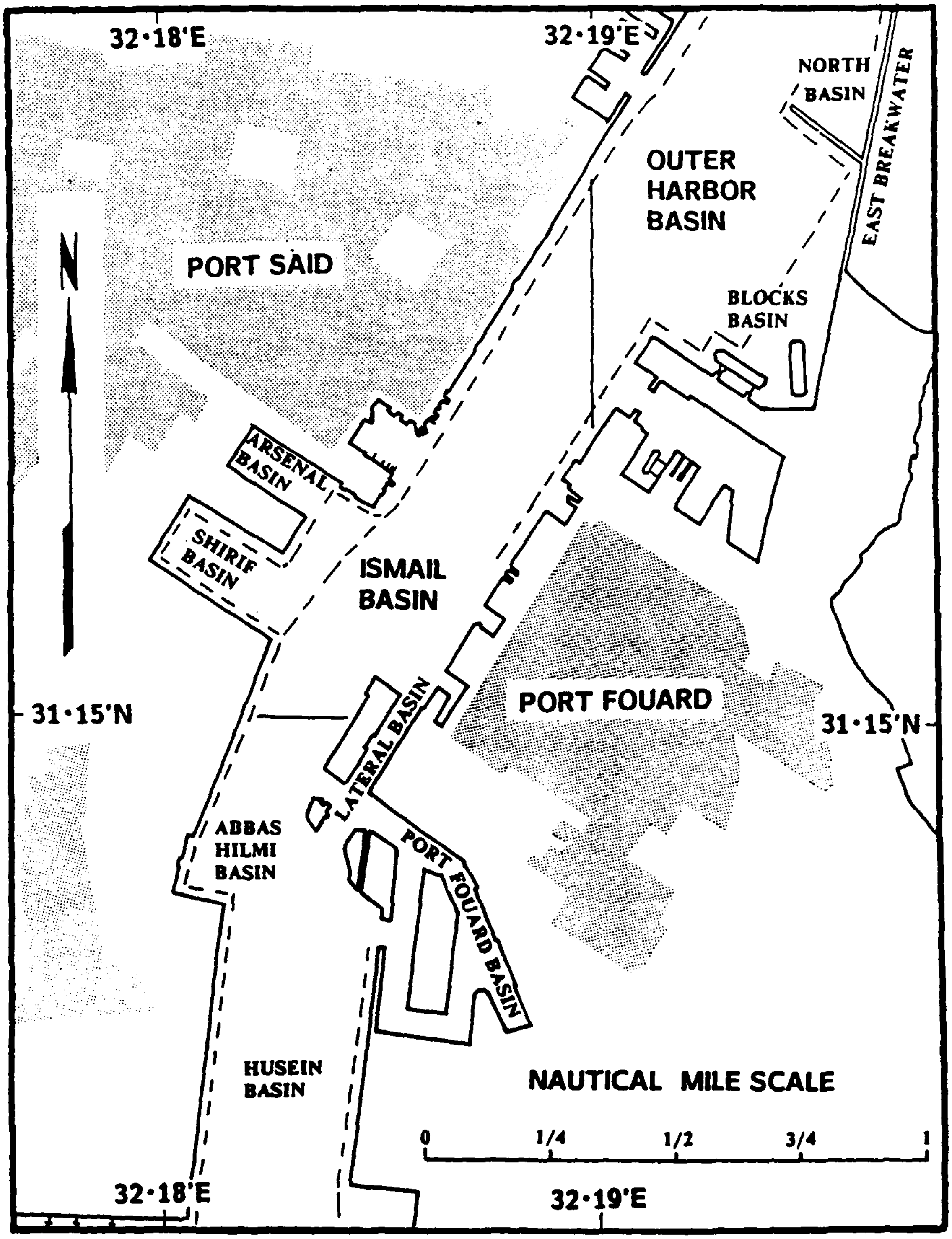


Figure 2-3. Port Said, Egypt.

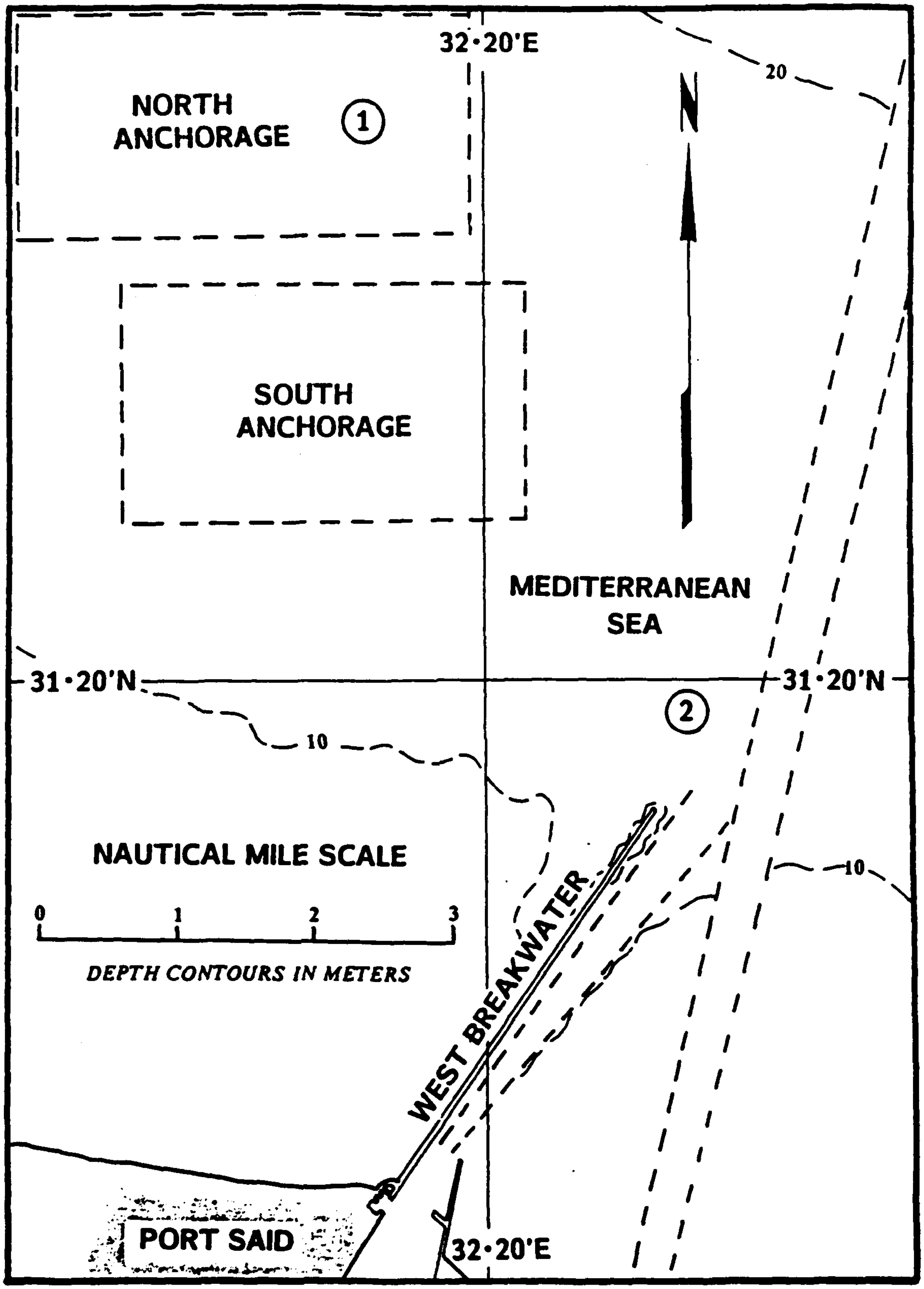


Figure 2-4. Anchorage for Port Said, Egypt.

The Port Directory (FICEURLANT, 1988) states that the current in the approach to Port Said varies depending on the wind. It usually sets south-southeast at .5 to 1.5 kts. Ships are advised to stay to the windward side of the channel. Tides in the vicinity of Port Said are negligible. Ships continuing on through the Suez Canal should be aware of very strong currents at times in the canal.

Specific hazardous conditions, vessel situations, and suggested precautionary/evasive action scenarios are summarized in Table 2-1.

Table 2.1. Summary of hazardous environmental c

HAZARDOUS CONDITION	INDICATORS OF POTENTIAL HAZARD	VESSEL SITUAT
1. Strong wind from the NW - Occurs following frontal passage and/or on backside of migratory lows. * Strongest in winter, occurs in autumn and spring. * Winds of 30 to 40 kts for 12 to 18 hrs. * Winds of 20 to 30 kts may persist for 2 or 3 days when migrating low stalls in northeast Mediterranean. * Waves up to 15-17 ft (5m) during strongest storms, 6-10 ft (2-3m) often persist for several days. * Likely to be accompanied by showery weather. * Typically preceded by strong southerly winds (Khamsin).	Advance Warning * Likely to follow Khamsin S'ly wind events associated with North African depression development. * Cyclogenesis in southern Aegean Sea or in Cyprus area are other causes of frontal passage followed by strong NW'ly in Said region. * Aegean Sea cyclogenesis often follows cyclogenesis over the Ionian Sea or over the Gulf of Genoa. * Falling pressure, increasing cloud cover and strong southwesterly wind precedes frontal passage and shift to northwesterlies. Duration * 12 to 18 hrs with normal winter migratory low. * 2 or 3 days when low stalls over northeast Mediterranean.	(1) Moo (2) Anch Anch (3) Arri (4) Smal Oper

of hazardous environmental conditions for Port Said, Egypt

)RS OF AL HAZARD	VESSEL LOCATION/ SITUATION AFFECTED	EFFECT - PRECAUTIONARY/EVASIVE ACTIONS
I follow Khamsin events l with North ıpression ıt. ;is in southern ı or in Cyprus ither causes of ıssage followed NW'ly in Said ı cyclogenesis ows cyclogenesis onian Sea or ulf of Genoa. essure, cloud cover and thwesterly wind rontal passage to rlies. rs with normal ratory low. s when low r northeast ean.	(1) Moored in Harbor	(a) <u>The harbor provides good protection from waves, but little protection from the wind.</u> * Buoy moored vessels may swing into fairway. * Holding may require anchors and tug assistance. * Use of harbor during storm periods is not recommended.
	(2) Anchored Outer Anchorages	(a) <u>The anchorage provides no protection from NW winds/waves</u>. * Wave energy spread over wide range of periods. * Causes additional hazards in alongside/well deck operations involving various length vessels. * Sortie to open ocean may be prudent action.
	(3) Arriving/Departing	(a) <u>Navigation hazardous in crowded harbor.</u> * Buoy-moored vessels in basins may swing into fairways. * Slow moving vessels may be blown out of fairways. * Maneuvering ships should stay to windward of fairways. * Ships should only slow for embark/debark of pilot. * Arriving/departing maneuvers not recommended during high wind conditions.
	(4) Small Boat Operations	(a) <u>Small boat operations outside harbor normally canceled.</u> * Small boat rigging should be to lee of large vessels. * Summertime sea breezes produce choppy conditions outside harbor. * Wide range of wave periods and various length vessel responses are additional hazard for small craft alongside operations.

Table 2.1. (Continue

HAZARDOUS CONDITION	INDICATORS OF POTENTIAL HAZARD	VESSE SITUA
2. <u>Strong wind from the south</u> - Locally known as "Khamsin". * Occurs late winter early spring, strongest March and April. * Maximum wind 25 to 35 kts, increasing as they veer from east through southwest. * Average duration a day or less in February, increases to 3 to 4 days in March/April, more than 5 days rare. * Brings hot, dry, dusty conditions. * Anomalous propagation, markedly reduced radar and radio ranges, strong mirages. * Typically followed by strong northwest winds.	<u>Advance Warning</u> * North African Depression (low) forms east of Atlas Mountains. * Depression moves eastward, pressure falling over eastern Libya/western Egypt. * Cirrus clouds advance from the west. * Local pressure starts to fall. * Northerly winds veering to east. * Rapid rise in temperature/drop in humidity. <u>Duration</u> * Average duration increases from a day in February to 3 or 4 days in March and April. * Wind veers to southwest and increases as front approaches. * Rapid drop in temperature, increase in humidity, and end of blowing dust marks frontal passage and end of Khamsin.	(1) Mo (2) Ar Ar (3) Ar (4) S O
3. <u>Variable Currents</u> - Responses to changing wind. * Variable direction and speed (.5 to 1.5 kts) near harbor entrance.	<u>Advance Warning</u> * The onset of strong winds, currents response to direction and speed. <u>Duration</u> * Duration of strong winds plus short adjustment time following end of strong winds.	(3) A

Table 2.1. (Continued)

ORS OF IAL HAZARD	VESSEL LOCATION/ SITUATION AFFECTED	EFFECT - PRECAUTIONARY/EVASIVE ACTIONS
<u>ng</u> rican Depression rms east of Atlas s. on moves eastward, falling over Libya/western	(1) Moored in Harbor	(a) <u>The harbor provides little protection from high winds.</u> * Unstable buoy moorings may allow vessels to swing into fairway. * Holding may require anchors and tug assistance. * Use of harbor during strong Khamsin events not recommended.
louds advance from . essure starts to y winds veering to se in ure/drop in	(2) Anchored Outer Anchorages	(a) <u>Problems related to wind effects and reduced visibility, radar and radio ranges.</u> * Advisable to use extra anchor to reduce swinging. * Secure vessel and use top side covers to protect from dust penetration. * Anticipate limited radar/radio propagation ranges. * Be aware of inaccurate visual ranges due to mirages.
duration increases ay in February to ys in March and rs to southwest eases as front s. op in temperature, in humidity, and owing dust marks assage and end of	(3) Arriving/Departing	(a) <u>Navigation hazardous in crowded harbor.</u> * Buoy-moored vessels in basins may swing into fairways. * Slow moving vessels may be blown out of fairways. * Maneuvering ships should stay to windward of fairways. * Ships should only slow for embark/debark of pilot. * Limited radar/radio ranges and questionable visual ranges due to mirage effects. * Arriving/departing maneuvers not recommended during strong Khamsin events.
l a	(4) Small Boat Operations	(a) <u>Minimal wave heights with offshore flow.</u> * Visibility reduced in blowing sand and dust. * Choppy wave conditions and swinging anchored vessels. * Unstable buoy-moored vessels in basins and maneuvering ships being blown out of fairways. * Rigging should be to lee of large vessels.
<u>ng</u> of strong winds, response to and speed. of strong winds t adjustment time end of strong	(3) Arriving/Departing	(a) <u>Variable currents near entrance.</u> * Currents normally run with wind, but become variable in entrance area where pilots embark/debark. * Ships should stay to windward and only slow for pilot.

SEASONAL SUMMARY OF HAZARDOUS WEATHER CONDITIONS

WINTER (November-March)

* Northwesterly winds and waves. Associated with migratory cyclones and fronts approaching from over the Mediterranean. Winds 35 to 45 kts, waves 15 to 17 ft. Extreme conditions usually last less than a day. Most frequent December through February.

* Persistent long period swell. Results from prevailing northwesterly winds over eastern Mediterranean. Swell of 8 to 12 ft at 14 to 18 second periods may persist for several days.

* Southeasterly winds (Khamsin). Late winter, southeasterly 25 to 35 kts in advance of African depressions. Increasing in frequency and duration as season progresses, averages 1 event lasting 24 hours in February to 3 events of 3 or 4 days each by March. Brings hot and dry weather, strongest events likely to cause violent dust storms.

SPRING (April-May)

* Southeasterly winds (Khamsin). Maximum wind speeds and frequencies March through April. Violent dust storms likely to accompany strong events. Seldom occur after May.

SUMMER (June-September)

* Coastal weather is mild under prevailing northerly flow which is enhanced by sea breeze. Outer anchorage can be choppy throughout day.

* Wave energy spread over wide range of periods. Regional northerly wind produces long period swell, local sea breeze enhancement produces short period sea, results in additional hazards for alongside/well-deck operations outside shoal zones/breakwaters.

AUTUMN (October)

* Northwesterly wind and waves. Typical Mediterranean marked change from summer to winter generally occurs in late October, early cold season storms generally moderate in strength.

REFERENCES

FICEURLANT, 1988: Port Directory for Said (1988), Egypt. Fleet Intelligence Center Europe and Atlantic, Norfolk, VA.

Hydrographic Department, 1961: Mediterranean Pilot, Volume V. Published by the Hydrographic Department, under the authority of the Lord Commissioners of the Admiralty, London.

PORT VISIT INFORMATION

January 1989. NOARL meteorologists R. Fett and D. Perryman met with U.S. Navy husbanding agent Abdou S. El Lamei to obtain much of the information used in this port evaluation.

3. GENERAL INFORMATION

This section is intended for Fleet meteorologists/ oceanographers and staff planners. Section 3.5 includes a general discussion of hazards and Table 3-4 provides a summary of vessel locations/situations, potential hazards, effect-precautionary/evasive actions, and advance indicators and other information by season.

3.1 Geographic Location

The Port of Said (31°16'N 32°18'E) is located at the Mediterranean entrance to the Suez Canal (Figure 3-1). The Port is about mid-way between Alexandria, Egypt to the west and Ashdod, Israel to the east-northeast, and about 150 nmi from each.

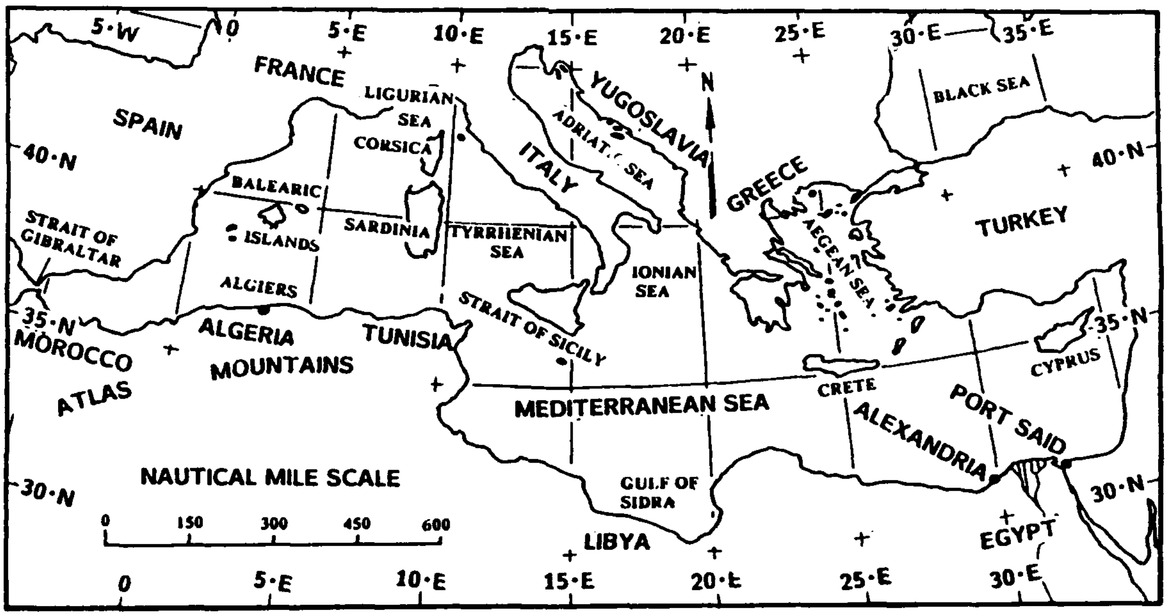


Figure 3-1. Mediterranean Sea.

The Port is situated a couple of miles west of the Port Suez bypass approach channel to the Suez Canal (Figure 3-2). The coastline in this area is unusually low and flat.

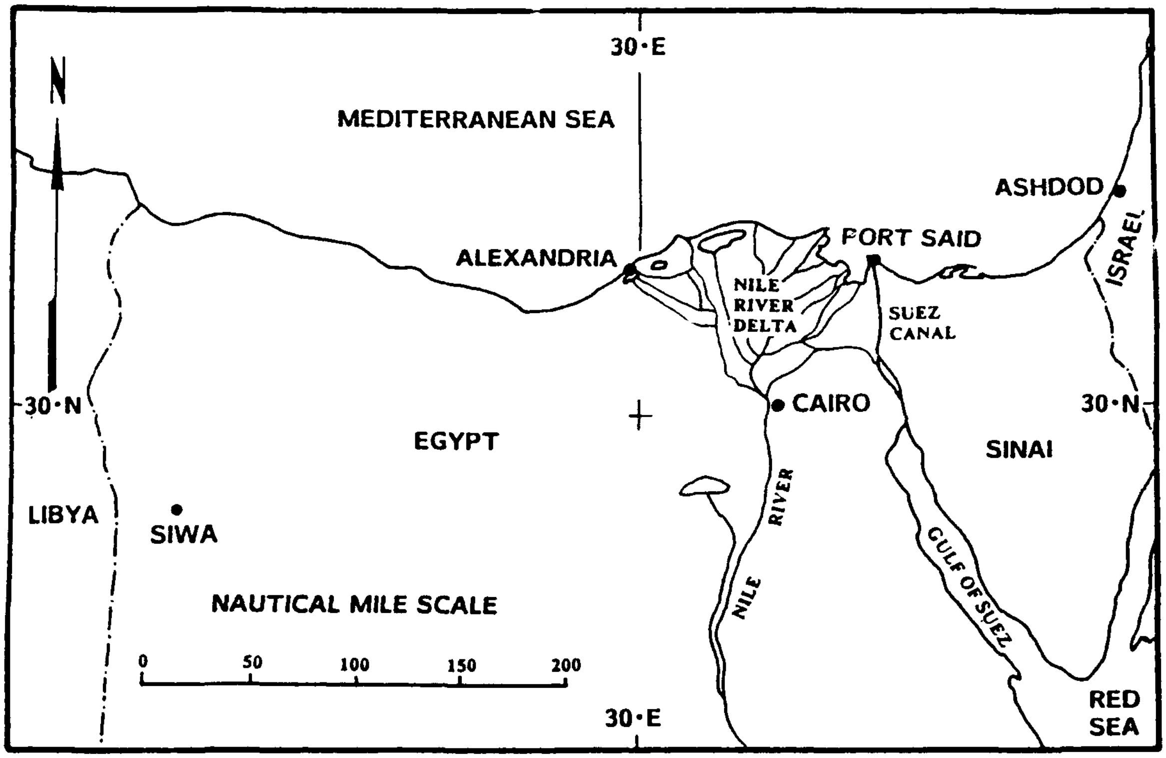


Figure 3-2. Northern Egypt and adjacent waters.

Port Said is an artificial harbor formed by two concrete breakwaters which extend seaward from the low sandy coast. The old approach channel to the Suez Canal forms the channel to Port Said (Figure 3-3). The city of Port Said is on the west side of the harbor, and the large suburb of Port Fouard is on the east side. There are a number of basins adjacent to the main channel which contain mooring buoys. The Outer Basin and Ismail Basin provide the deepest draft. Navy vessels typically moor inside the breakwaters (FICEURLANT, 1987). A series of 4 mooring buoys are used to anchor each ship, generally two forward and two aft. There are no pier side berths available to Navy ships and there is no designated Fleet Landing.

There are two large anchorage areas northwest of the entrance to the Suez Canal and Port Said (Figure 3-4). They are fully exposed to open seas wind and waves.

Daylight navigation into Port Said is recommended (FICEURLANT, 1987). The approach zones typically hold a large number of anchored vessels awaiting passage through the Canal, the low coastline provides poor radar return and currents near the seaward end of the breakwaters tend to be quite variable. Ships are advised to stay to the windward side of the channel and should not stop in the outer channel. Pilotage is compulsory. Pilots board at the seaward end of the breakwater.

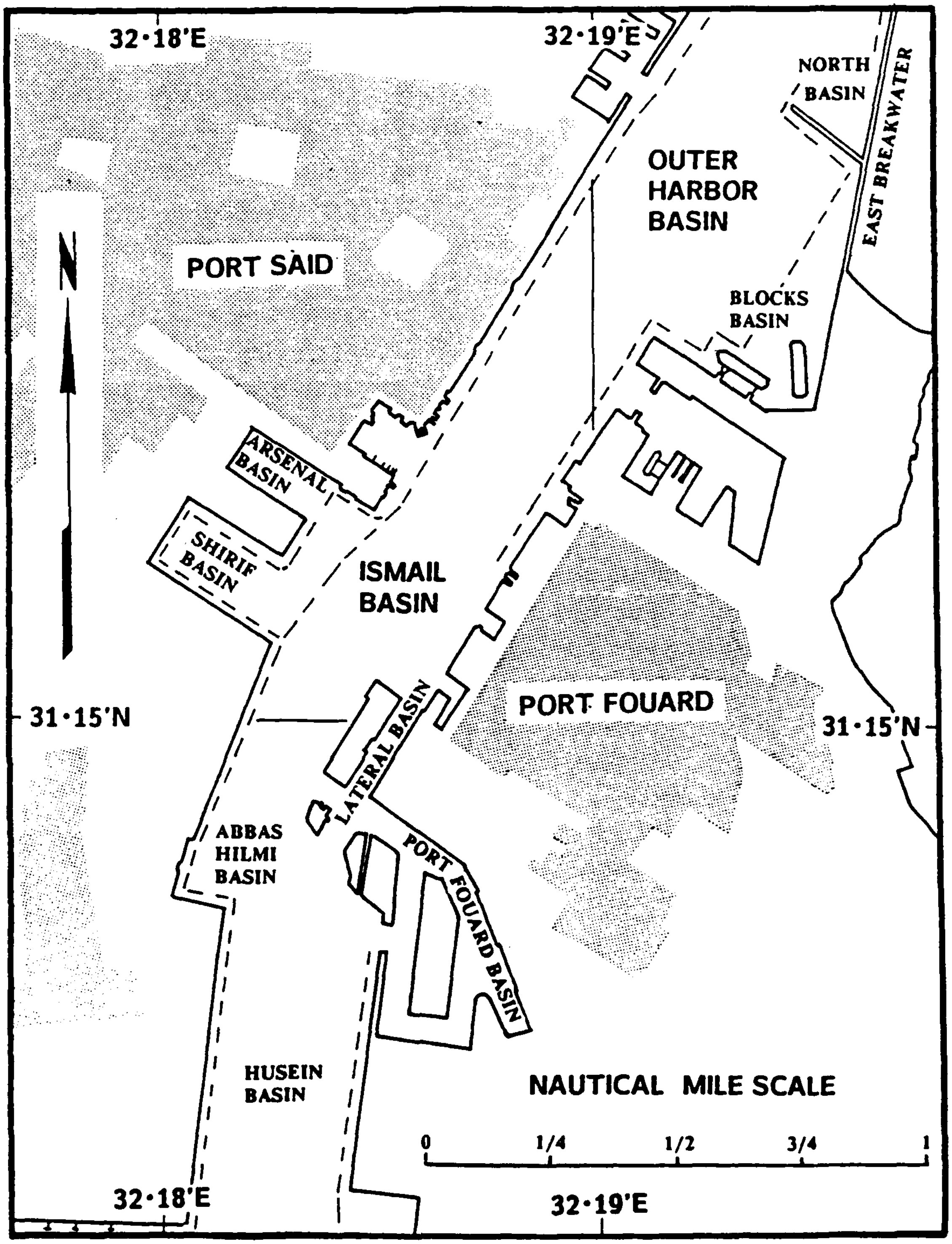


Figure 3-3. Port Said, Egypt.

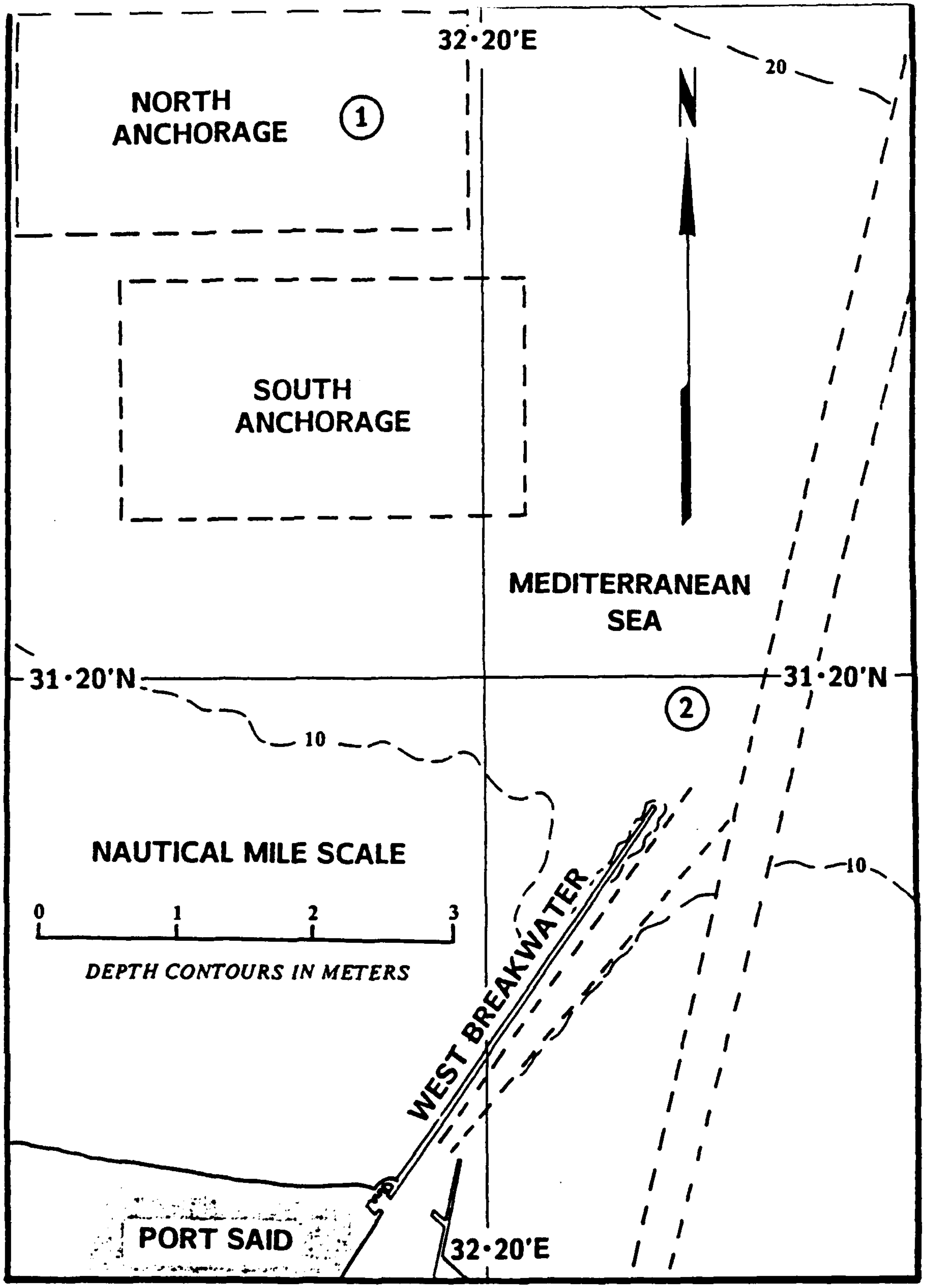


Figure 3-4. Anchorage for Port Said, Egypt.

3.2 Qualitative Evaluation of the Port of Said

The anchorage areas inside the breakwaters are well protected, wave heights do not exceed 3-4 ft (1m) even in the worst conditions. The outer anchorages, however, are exposed to winds and waves generated by passing storms. Typical wave heights at the outside anchorages during storms are 6 to 10 ft (2 to 3m), but can be as high as 15-17 ft (5m).

Ship traffic is heavy in the approaches and harbor. Numerous anchored vessels typically occupy both the outer anchorage areas and mooring spaces within the harbor on either side of the channel. Because of the narrow fairway, numerous buoys and other navigational hazards, mooring operations within the harbor typically require tug assistance.

Due to the low coastline, poor radar returns and mirages, plus periods of reduced visibility in haze and/or dust, navigation is difficult. Daylight navigation is recommended (FICEURLANT, 1987).

3.3 Currents and Tides

The Port Directory for Said (FICEURLANT, 1987) states that the currents in the approaches are variable and depend on the wind. The currents usually have a south-southeast set at .5 to 1.5 kts. Current direction and speed are most variable near the entrance to the harbor.

Tides and tidal currents in the vicinity of Port Said are negligible. Ships continuing through the Suez Canal should be aware of the existence of extremely strong currents in various parts of the canal.

3.4 Visibility

During the Khamsin period (February through May) dust storms reduce visibility to less than a mile. During March and into April dust storms may last for 2 to 3 days. Fog is uncommon in Port Said. It is a summertime phenomenon and on a few days in early morning will restrict visibility to less than a mile.

3.5 Hazardous Conditions

The Port of Said is very congested. Ships are anchored in the approach areas and moored to buoys on either side of the channel in the harbor. Maneuvering for mooring during even moderate winds can be extremely difficult because of traffic congestion and limited space.

The worst weather conditions occur in winter when low pressure systems or frontal systems pass through the area. Wave heights inside the breakwaters are minimal but winds up to 40 kts are experienced and they will cause problems for ships while they are maneuvering to moor. Wave heights at the outside anchorages can be as high as 15 to 17 ft (5m), 6 to 10 ft (2-3m) is typical with winter storms. The strongest winds are from the northwest and occur after the passage of a cold front or on the backside of lows. Long period swell of 6 to 10 ft (2 to 3m) may persist in the outer anchorages for several days at a time in response to persistent west to northwest winds over the central and eastern Mediterranean.

Strong southeasterly winds (Khamsin) occur in late winter through spring (February through May). They create hazardous conditions due to blowing dust and restrictions to visibility.

Currents are variable near the entrance and generally respond to the winds. Ships should stay to the windward side of the channel to allow room to maneuver and should not stop but only slow down to embark/debark pilots (FICEURLANT, 1987).

A seasonal summary of various known environmental hazards that may be encountered in the Port of Said follows:

A. <u>Winter</u> (November through March)

The worst weather conditions occur when low pressure systems and/or fronts pass through the eastern Mediterranean Sea. The strongest winds typically occur following frontal passage and/or on the west side (backside) of the lows. Northwesterly winds of 30 to 40 kts lasting for 12 to 18 hours are typical. It is not uncommon for 20 to 30 kt northwesterly winds to continue for 2 or 3 days following the stronger winds. Northwesterly swell as high as 15 to 17 ft (5m) will be experienced during the stronger events, 6 to 10 ft (2 to 3m) swell is typical during stormy weather. The eastern Mediterranean experiences longer period swell, up to 16 to 18 seconds, than the western and central Mediterranean which is generally limited to 10 to 12 second periods. The longer period swell is more hazardous to the larger ships. Significant wave energy is also available in the shorter period waves. Therefore, alongside operations between different length vessels can be additionally hazardous due to differing ship's responses to different wave lengths.

Strong southeasterly winds (Khamsin) occur from February through May. These events are associated with low pressure systems approaching from the west and then curving northeastward prior to reaching Egypt. The duration and intensity of these events increase as the season passes. By March southeasterly winds of 25 to 35 kts may persist for 3 to 4 days. The southeasterlies bring hot and dry weather and those with winds in excess of 25 kts typically result in violent dust storms.

SPRING (April-May)

The Khamsin southeasterlies reach maximum intensity and duration in early April. Winds of 25 to 35 kts may persist for 3 or 4 days. Visibility will be reduced to less than 1 nmi due to blowing dust. Settling dust will create friction hazards for all top side or exposed systems. Weaker Khamsin southeasterlies may persist for weeks at a time during the late winter-early spring period.

SUMMER (June-September)

Summer weather is mild. Northerly winds from off the Mediterranean prevail bringing cool moist air to the coastal regions. Extremely hot and dry conditions exist a few miles inland. Daily seas breezes enhance the onshore large scale flow. Afternoon sea breezes of 15 to 20 kts will produce choppy wave conditions in the outer anchorages. At night the prevailing northerly winds often negate the normal off-shore land breeze resulting in near calm conditions along the coast.

AUTUMN (October and November)

Autumn is delayed in the southeast Mediterranean by about a month from the western and central areas. Also, the characteristic rapid transition from summer to winter prevalent over most of the Mediterranean is less dramatic in this area. By early November weak to moderate northwesterly wind events associated with northeastward moving cyclones begin to occur with winter time frequently.

3.6 Harbor Protection

The breakwaters which define the harbor provide significant protection from waves. Winds of even moderate sea breeze intensity (12-18 kts) can cause problems during maneuvering and/or mooring action within the busy and crowded harbor.

3.6.1 Wind and Weather

The Port of Said, located on a low lying flat featureless coastline, is exposed to the full force of winds from all directions. Dust storms will occur during late winter and spring during moderate to strong Khamsin events. Passage of winter frontal systems bring the worst weather conditions with strong winds, precipitation and reduced visibility.

3.6.2 Waves

The harbor is protected from wave action by the defining breakwaters. During strong winter storms maximum waves in the outer basins are limited to about 3 ft (1m). However, the outer anchorages are fully exposed to open sea conditions. Swell to 15-17 ft (5m) will occur during strong northerly wind events. Swell of 6 to 10 ft (2-3m) may persist for a week or more over the eastern Mediterranean. In summer time the outer anchorage and approach areas will frequently experience choppy conditions during the afternoon maximum sea breeze conditions. Because of the prevailing large scale northwesterly winds over the eastern Mediterranean, plus the local sea breeze, wave energy tends to be spread over a broad range of wave periods.

This region of the Mediterranean experiences longer period swell than the central and western regions. Even during summer swell with 15 to 16 second periods will occur. In general the swell energy is focused in longer period waves in this region. This can result in changes in the response of longer vessels (major combatants) as compared to the responses experienced in the central and western portion of the Mediterranean Sea. This does not mean that large waves are not present in the middle and shorter wave periods. With large wave heights spread across a larger range of periods, alongside operations of various size vessels becomes even more hazardous.

There are no bays or deep anchorages in this area that are protected from the heavy, westerly clockwise through northerly, waves and winds. Unless vessels can move inside harbors with protecting breakwaters or inside areas protected by extensive shoals, sortie to the open sea is recommended during storm conditions.

Table 3-1 provides the shallow water wave conditions at the two designated points when the deep water swell enters the area.

<u>Example: Use of Table 3-1</u>.

For a <u>deep water</u> wave condition of 10 feet, 12 seconds, from 330°, the approximate shallow water wave conditions are:

<u>Point 1:</u> 8 feet, 12 seconds, from 360°
<u>Point 2:</u> 6 feet, 12 seconds, from 355°

Table 3-1. Shallow water wave directions and relative height conditions versus deep water period and direction (see Figure 3-3 for location of the points).

FORMAT: Shallow Water Direction
Wave Height Ratio: (Shallow Water/Deep Water)

PORT SAID POINT 1: Anchorage Depth 56 ft

Period (sec)	6	8	10	12	14	16
Deep Water Direction	Shallow Water Direction and Height Ratio					
270°	320° .6	325° .5	335° .5	340° .5	340° .5	335° .4
300°	320° .7	335° .6	345° .6	350° .6	350° .6	355° .5
330°	335° 1.0	345° 1.0	345° .8	360° .8	360° .6	005° .5
360°	360° .8	005° .6	010° .6	010° .5	020° .4	020° .4
030°	030° .9	025° .9	025° 1.0	020° .5	020° .5	020° .4
060°	055° .7	055° .7	050° .8	045° .9	045° .4	030° .5

PORT SAID POINT 2: Adjacent to Mid-Channel Depth 40 ft

Period (sec)	6	8	10	12	14	16
Deep Water Direction	Shallow Water Direction and Height Ratio					
270°	320° .6	330° .6	340° .5	345° .5	345° .4	345° .3
300°	325° .7	340° .6	340° .5	340° .4	355° .4	355° .4
330°	340° .6	350° .6	350° .6	355° .6	355° .3	350° .5
360°	360° .8	005° .6	360° .4	360° .4	355° .3	355° .3
030°	020° .9	020° .6	336° .6	010° .4	005° .5	005° .3
060°	045° .6	040° .6	025° .5	030° .4	030° .3	020° .3

Situation-specific shallow water wave conditions resulting from deep water wave propagation are given in Table 3-1, while the seasonal climatology of wave conditions in the harbor resulting from the propagation of deep water waves into the harbor are given in Table 3-2. If the actual or forecast deep water wave conditions are known, the expected conditions at the two specified harbor areas can be determined from Table 3-1. The mean duration of the condition, based on the shallow water wave heights, can be obtained from Table 3-2.

<u>Example: Use of Tables 3-1 and 3-2</u>.

The forecast for <u>wave conditions tomorrow</u> (winter case) <u>outside the harbor are</u>: 15 feet, 12 seconds, from 330°

Expected <u>shallow water conditions</u> and <u>duration</u>:

	Point 1	Point 2
Height	12 feet	9 feet
Period	12 seconds	12 seconds
Direction	from 360°	from 355°
Duration	11 hours	10 hours

Interpretation of the information from Tables 3-1 and 3-2 provides guidance on the local wave conditions expected tomorrow at the specified area points. The duration values are mean values for the specified height range and season. Knowledge of the <u>current synoptic pattern and forecast/expected duration should be used when available</u>.

Possible applications to small boat operations are selection of the mother ships anchorage point, and/or areas of small boat work. The condition duration information provides insight as to how long before a change can be expected. The local wave direction information can be of use in selecting anchorage configuration and related small boat operations, including tending activities.

Table 3-2. Shallow water climatology as determined from deep water wave propagation. Percent occurrence, average duration or persistence, and wave period of maximum energy for wave height ranges of greater than 3.3 ft (1 m) and greater than 6.6 ft (2 m) by climatological season.

PORT SAID POINT 1:	WINTER	SPRING	SUMMER	AUTUMN
>3.3 ft (1 m)	NOV-APR	MAY	JUN-SEP	OCT
Occurrence (%)	33	10	26	13
Average Duration (hr)	18	12	19	17
Period Max Energy (sec)	9	9	9	9
>6.6 ft (2 m)	NOV-APR	MAY	JUN-SEP	OCT
Occurrence (%)	6	1	2	0
Average Duration (hr)	11	6	16	NA
Period Max Energy (sec)	12	10-11	11	NA
PORT SAID POINT 2:	WINTER	SPRING	SUMMER	AUTUMN
>3.3 ft (1 m)	NOV-APR	MAY	JUN-SEP	OCT
Occurrence (%)	15	2	7	3
Average Duration (hr)	18	22	18	9
Period Max Energy (sec)	11	11	10-11	10
>6.6 ft (2 m)	NOV-APR	MAY	JUN-SEP	OCT
Occurrence (%)	1	0	<<1	0
Average Duration (hr)	10	NA	6	NA
Period Max Energy (sec)	12	NA	12	NA

Local wind wave conditions are provided in Table 3-3. Because of the nearly straight coastline in this area there are no specific fetches that can be defined. Table 3-3 provides wind waves for a range of fetch lengths and wind speeds. The time to reach the fetch limited height assumes an initial flat ocean. With a pre-existing wave height, the times are shorter.

Table 3-2. Port Said. Local wind waves for fetch limited conditions (based on JONSWAP model).

Format: height (feet)/period (seconds)
time (hours) to reach fetch limited height

Fetch Length (n mi) \ Local Wind Speed (kt)	18	24	30	36	42
5	<2 ft	2/3-4 1	2-3/3-4 1	3/3-4 1-2	3-4/3-4 1
10	2/3-4 1-2	3/3-4 2	3-4/4 2	4/4-5 1-2	5/5 1-2
15	2-3/4 2	3-4/4 2	4/4-5 2	5/5 2	6/5 2
20	3/4-5 2-3	4/4-5 3	5/5 3	6/5-6 3-4	7/5-6 3
25	3-4/4-5 3	4/5 3	5-6/5 3	6-7/6 3	7-8/6 3
30	4/4-5 3	5/5-6 4	6/6 3-4	7/6 3-4	8/6-7 3

Example: Small boat wave forecasts for a location that has a 15 n mi limited fetch to the south (based on the assumption that swell is not a limiting condition).

Forecast for Tomorrow:

Time	Wind (Forecast)		Waves (Table 3-3)
prior to 1000 LST	S	8-12 kt	< 2 ft
1000 to 1400	S	16-20 kt	2-3 ft at 4 sec by 1200
1400 to 1900	S	22-26 kt	building to 3-4 ft at 4 sec by 1600

Interpretation: Assuming that the limiting factor is waves greater than 3 feet, small boat operations will become marginal by 1200 and restricted by 1600.

Combined wave heights are computed by finding the square root of the sum of the squares of the wind wave and swell heights. For example, if the wind waves were 3 ft and the swell 8 ft the combined height would be about 8.5 ft.

$$\sqrt{3^2 + 8^2} = \sqrt{9 + 64} = \sqrt{73} \approx 8.5$$

Note that the increased height is relatively small. Even if the two wave types were of equal height the combined heights are only 1.4 times the equal height. In cases where one or the other heights are twice that of the other, the combined height will only increase over the larger of the two by 1.12 times (10 ft swell and 5 ft wind wave combined results in 11.2 ft height).

3.6.3 Wave Data Uses and Considerations

Local wind waves build up quite rapidly and also decrease rapidly when winds subside. The period and, therefore, length of wind waves is generally short relative to the period and length of waves propagated into the harbor (see Appendix A). The shorter period and length result in wind waves being characterized by choppy conditions. When wind waves are superimposed on deep water waves propagated into shallow water, the waves can become quite complex and confused. Under such conditions, when more than one source of waves is influencing a location, tending or joint operations can be hazardous even if the individual wave train heights are not significantly high. Vessels of various lengths may respond with different motions to the diverse wave lengths present. The information on wave periods, provided in the previous tables, should be considered when forecasts are made for joint operations of various length vessels.

3.7 Protective and Mitigating Measures

3.7.1 Moving to a New Anchorage

For ships anchored in the outer anchorage movement to any anchorage within the harbor will provide significant protection from high waves. When entering or leaving the harbor ships should stay to the windward of the channel and not stop to embark or debark pilots.

3.7.2 Scheduling

Large vessel wind sensitive maneuvers may be delayed for several days when winter fronts pass through the area and/or slow moving cyclones are over the northeastern Mediterranean. Small boat operations in the outer anchorage or approach areas are likely to be curtailed daily during summer because of afternoon to early evening strong sea breezes. During winter small boat operations in the outer anchorage and approach areas are likely to be curtailed for extended periods, extending through day and night, during strong conditions.

During the Khamsin season (February through May) periods of offshore southeasterly winds may persist for several days. Otherwise, onshore northerly winds prevail. Near calm conditions are most likely during summer night and very early morning periods. The sea breeze is usually established by 0700-0800 during summer and by 1000 during spring and autumn (Meteorological Officer, 1962, Vol. I). In winter, during periods of fair weather, the sea breeze will be established by around noon.

3.8 Regional and Local Indication of Hazardous Weather Conditions

The following sequences are listed in approximate longer to shorter lead times, generally regional to local in nature. Determination of regional indicators will require access to outside data via communication or remote sensing systems.

North African Depression Development and Approach

- Strong surface ridging across Morocco and Algiers (Station 60390) surface wind shift from southwest to northwest.
- Cumulonimbus/thunderstorm development over northern Africa mountain and coastal areas.
- Falling pressure over eastern Libya and western Egypt area.

Potential Khamsin in Advance of Depression

- Easterly wind reported by station SIWA (61416/61417)
- Appearance of high cirrus approaching from west
- Locally falling pressure
- Wind veers from northerly to easterly
- Rapid decrease of humidity
- Wind veers from east to south
- Blowing dust develops

Duration and Intensity of Khamsin

- Increases with months from late winter into spring until April, rapid drop off through May into early June.

- Approach path; February into March approaches on coastal track, duration of Khamsin about a day. March, April and May over land track south of 30°N, duration 3-4 days before cold frontal passage.

Frontal Passages Strong Northwesterly Winds, High Seas to Follow.

- Wind veers to southwest, speed increases and visibility decreases in blowing dust/sand prior to frontal passage.
- Sudden wind shift to northwest, temperature drops and humidity rises after front passes.
- Rapid drop off of blowing sand, dust and haze may linger for a day or so
- Rising pressure and gradually decreasing northwesterlies over a couple day period. Northerly swell may persist for 2 to 4 days if associated low stalls in Cyprus area.

Anomalous Propagation, Low Level Turbulence, Mirages and Reduced Visibility

- Indicators of onset of Khamsin events are also indicators of onset of following conditions.
    - Strong temperature inversions between surface and 3000 ft.

- Helicopters may be out of radio contact at 1 to 2 mile range.
- Anomalous radar ranges.
- Morning Inferior mirages (distance to horizon shortened) and evening Superior mirages (distance to horizon increased).
- Strong wind shear near top of inversion.
- Marked reduction of slant range during daylight periods.
  - Reduced surface visibility in blowing dust/sand.

3.9 Summary of Problems, Actions, and Indicators

Table 3-4 is intended to provide easy-to-use seasonal references for meteorologists or ships using the Port Said. Table 2-1 (section 2) summarizes Table 3-4 and is intended primarily for use by ship captains.

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Table 3.4. Potential problem sit

VESSEL LOCATION/ SITUATION	POTENTIAL HAZARD	EFFECT - PRECAUTIO
1. Moored in Harbor Strongest in winter occurs in Spring and Autumn	a. Northwesterly Winds/Waves - Occurs following frontal passage and/or on backside of migratory lows. Winds 30 to 40 kts for 12 to 18 hours, not uncommon for 20-30 kt winds to continue for 2 or 3 days or as long as low remains nearly stationary in NE Mediterranean. Swell waves of 15-17 ft (5m) - occur during strong winter storms. Swell of 6-10 ft (2-3m) often persists for a week or more. Wave energy is spread across a wide spectrum of frequencies/ periods. Waves inside breakwaters limited to about 3-4 ft (1m) in strongest winter storms.	a. Buoy moored vesse fairway. Movement fro extremely risky. Typi harbors plus unstable may require anchors an addition to added moor during storm periods i
Occurs February through early June most intense and longest duration March and April	b. Southeasterly Winds/Waves - Locally known as "Khamsin", a regional form of "Sirocco". Winds of 25 to 35 kts may persist for 3 to 4 days in advance of approaching N. African depressions. Hot, dry, dusty winds from deserts to south. High personal discomfort, anomalous radar/ radio propagation, reduced horizontal and slant range visibility, fine dust penetration all systems, strong wind shear near top of inversion. During peak season (March/April) winds may persist from the SE for a number of days but at speeds less than 25 kts and with minimum blowing dust but still hot and dry.	b. Problems similar westerly winds. Diffe movements and stress w direction and season o shift to spring vice w winds. Use of harbor recommended.

Table 3.4. Potential problem situations at Port Said, Egypt

...NTIAL HAZARD	EFFECT - PRECAUTIONARY/EVASIVE ACTION	ADVANCE INDICATO... INFORMATION ABOU...
...westerly ...s - Occurs fol- ...ntal passage ...y backside of mi- ...ws. Winds 30 to ... 12 to 18 hours, ...on for 20-30 kt ...ontinue for 2 or as long as low ...arly stationary ...terranean. Swell ...5-17 ft (5m) - ...ng strong winter ...well of 6-10 ft ...en persists for a ...re. Wave energy across a wide ...f frequencies/ ...de breakwaters about 3-4 ft ...rongest winter	a. Buoy moored vessels may swing into fairway. Movement from mooring will be extremely risky. Typical hazards of crowded harbors plus unstable buoy mooring. Holding may require anchors and tug assistance in addition to added mooring lines. Use of harbor during storm periods is not recommended.	a. Strong northweste... frontal passage and/or ... migratory lows. These ... for several days when ... becomes nearly station... Eastern Mediterranean ... general source regions... Sea, Gulf of Antalya t... Africa south of the At... two areas are active f... April. North African ... eastward far enough to ... area are most likely i... June. Strong northwest... preceded by strong Kha... wind veering to southw... indicates the approach ... passage winds become n... dust drops off rapidly... and humidity increases...
...easterly ...s - Locally known ...n", a regional ...irocco". Winds ...5 kts may persist ... days in advance ...hing N. African ...s. Hot, dry, ...s from deserts to ...gh personal dis- ...nomalous radar/ ...agation, reduced and slant range ..., fine dust ...n all systems, ...d shear near top ...on. During peak ...rch/April) winds ...t from the SE for ...f days but at ...s than 25 kts and ...um blowing dust ...hot and dry.	b. Problems similar to those under north-westerly winds. Difference will be ship movements and stress will be in opposite direction and season of most likely recurrence shift to spring vice winter for northwesterly winds. Use of harbor during Khamsin season not recommended.	b. Khamsin, a regiona... winds, are hot, dry and ... from out of the desert. ... early spring event and ... March and April. Stron... associated with the app... depressions. North Afr... ment is likely with str... across Morocco. A wind ... northwest at Algier (60... cyclogenesis east of th... Cumulonimbus developmen... northwestern Egypt, evi... imagery, indicates depr... Falling pressure over t... easterly surface wind r... (61416/61417) indicates ... the depression. Local ... approach and Khamsin de... falling pressure, appro... the west, surface winds ... easterly, rapid decreas... continuing to veer to s... ing dust. The duration ... from less than a day in ... in March and April. Th... typically take an overw... Khamsin season, shiftin... and over land in spring ... conventional data and c... the late season systems ... define and track.

uations at Port Said, Egypt

ONARY/EVASIVE ACTION	ADVANCE INDICATORS AND OTHER INFORMATION ABOUT POTENTIAL HAZARD
els may swing into om mooring will be ical hazards of crowded buoy mooring. Holding nd tug assistance in ring lines. Use of harbor is not recommended.	a. Strong northwesterly winds occur following frontal passage and/or on the back side of migratory lows. These wind events will persist for several days when the associated low becomes nearly stationary in the Cyprus area. Eastern Mediterranean cyclones have three general source regions: Aegean Sea/Cretan Sea, Gulf of Antalya to Cyprus, and North Africa south of the Atlas Mountains. The first two areas are active from late October through April. North African depressions that move eastward far enough to influence the Port Said area are most likely in February through early June. Strong northwesterlies are generally preceded by strong Khamsin events. Southerly wind veering to southwesterly and increasing indicates the approach of the front and with passage winds become northwesterly, blowing dust drops off rapidly, temperature drops off and humidity increases.
to those under north- erence will be ship will be in opposite of most likely recurrence winter for northwesterly during Khamsin season not	b. Khamsin, a regional name for Sirocco type winds, are hot, dry and dusty southerly flow from out of the desert. They are a late winter early spring event and are most intense in March and April. Strong Khamsin events are associated with the approach of north African depressions. North African depression development is likely with strong surface ridging across Morocco. A wind shift from southwest to northwest at Algier (60390) is an indicator of cyclogenesis east of the Atlas mountains. Cumulonimbus development over Libya and northwestern Egypt, evident in satellite imagery, indicates depression development. Falling pressure over this same area and/or an easterly surface wind report from SIWA (61416/61417) indicates eastward movement of the depression. Local indicators of depression approach and Khamsin development include: falling pressure, approach of high cirrus from the west, surface winds veering from north to easterly, rapid decrease in humidity, winds continuing to veer to south, and onset of blowing dust. The duration increases on average from less than a day in February to 2 to 3 days in March and April. These depressions/cyclones typically take an overwater track early in the Khamsin season, shifting southward to coastal and over land in spring. Due to lack of conventional data and classic cloud development the late season systems are more difficult to define and track.

Table 3.4 (Co

VESSEL LOCATION/ SITUATION	POTENTIAL HAZARD	EFFECT - PRECAUTIC
2. <u>Anchored Outer Anchorages</u> Strongest in winter occurs in Spring and Autumn	a. <u>Northwesterly Winds/Waves</u> - Occurs following frontal passage and/or on backside of migratory lows. Winds 30 to 40 kts for 12 to 18 hours, not uncommon for 20-30 kt winds to continue for 2 or 3 days or as long as low remains nearly stationary in NE Mediterranean. Swell waves of 15-17 ft (5m) - occur during strong winter storms. Swell of 6-10 ft (2-3m) often persists for a week or more. Wave energy is spread across a wide spectrum of frequencies/periods. Waves inside breakwaters limited to about 3-4 ft (1m) in strongest winter storms.	a. Worst conditions a Conditions will be prec winter storms. Sortie prudent. Wide range of marked differences in v alongside/well deck ope hazardous.
Occurs February through early June most intense and longest duration March and April	b. <u>Southeasterly Winds/Waves</u> - Locally known as "Khamsin", a regional form of "Sirocco". Winds of 25 to 35 kts may persist for 3 to 4 days in advance of approaching N. African depressions. Hot, dry, dusty winds from deserts to south. High personal discomfort, anomalous radar/radio propagation, reduced horizontal and slant range visibility, fine dust penetration all systems, strong wind shear near top of inversion. During peak season (March/April) winds may persist from the SE for a number of days but at speeds less than 25 kts and with minimum blowing dust but still hot and dry.	b. Problems generally fects, limited radio/rad ranges, and deposition a dust. Holding is good, advisable to restrict sw covers should be in plac to protect from dust per

Table 3.4 (Continued)

TIAL HAZARD	EFFECT - PRECAUTIONARY/EVASIVE ACTION	ADVANCE INDICAT INFORMATION ABO
esterly s - Occurs fol- ntal passage ackside of ows. Winds 30 for 12 to 18 uncommon for 20- s to continue for s or as long as s nearly station- lediterranean. s of 15-17 ft r during strong ms. Swell of 6-) often persists or more. Wave pread across a um of frequen- s. e breakwaters about 3-4 ft ongest winter	a. Worst conditions at outer anchorages. Conditions will be precarious during strong winter storms. Sortie to open sea may be prudent. Wide range of wave periods result in marked differences in vessel responses, alongside/well deck operations particularly hazardous.	a. Strong northwest frontal passage and/o migratory lows. Thes for several days when becomes nearly statio Eastern Mediterranean general source region Sea, Gulf of Antalya Africa south of the A two areas are active April. North African eastward far enough t area are most likely June. Strong northwe preceded by strong Kh wind veering to south indicates the approac passage winds become dust drops off rapidl and humidity increase
sterly - Locally known , a regional occo". Winds kts may persist ays in advance ng N. African Hot, dry, from deserts to personal anomalous propagation, zontal and visibility, netration all ong wind shear inversion. season) winds may the SE for a ys but at than 25 kts and blowing dust t and dry.	b. Problems generally limited to wind effects, limited radio/radar and visibility ranges, and deposition and penetration of dust. Holding is good, extra anchors may be advisable to restrict swinging. Top side covers should be in place and vessels closed up to protect from dust penetration.	b. Khamsin, a regio winds, are hot, dry a from out of the deser early spring event an March and April. Str associated with the a depressions. North A ment is likely with s across Morocco. A wi northwest at Algier (cyclogenesis east of Cumulonimbus developm western Egypt, eviden indicates depression pressure over this sa surface wind report f indicates eastward mo Local indicators of d Khamsin development i approach of high cirr winds veering from n decrease in humidity, to south, and onset o duration increases on day in February to 2 April. These depress take an overwater tra season, shifting sout land in spring. Due data and classic clou season systems are mo track.

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PO</th><th>ADVANCE INDICATORS AND OTHER INFORMATION ABOUT POTENTIAL HAZARD</th></tr>
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Table 3.

VESSEL LOCATION/ SITUATION	POTENTIAL HAZARD	EFFECT - PRECAU
3. Arriving/Departing Strongest in winter occurs in Spring and Autumn	a. Northwesterly Winds/Waves - Occurs following frontal passage and/or on backside of migratory lows. Winds 30 to 40 kts for 12 to 18 hours, not uncommon for 20-30 kt winds to continue for 2 or 3 days or as long as low remains nearly stationary in NE Mediterranean. Swell waves of 15-17 ft (5m) - occur during strong winter storms. Swell of 6-10 ft (2-3m) often persists for a week or more. Wave energy is spread across a wide spectrum of frequencies/periods. Waves inside breakwaters limited to about 3-4 ft (1m) in strongest winter storms.	a. Navigation haza Ships buoy-moored ir narrow fairway and/c blown out of fairway should stay to windw embark/debark actior departing maneuvers wind conditions.
Occurs February through early June most intense and longest duration March and April	b. Southeasterly Winds/Waves - Locally known as "Khamsin", a regional form of "Sirocco". Winds of 25 to 35 kts may persist for 3 to 4 days in advance of approaching N. African depressions. Hot, dry, dusty winds from deserts to south. High personal discomfort, anomalous radar/radio propagation, reduced horizontal and slant range visibility, fine dust penetration all systems, strong wind shear near top of inversion. During peak season (March/April) winds may persist from the SE for a number of days but at speeds less than 25 kts and with minimum blowing dust but still hot and dry.	b. Problems simila westerly winds. Di movements and stress opposite direction a occurrence shifts fı and radio propagatic effects cause visual able.
All Seasons	c. Currents near entrance variable direction/speed. Generally run with the wind at .5 to 1.5 kts.	c. Currents near t response to changing conditions should be wind speed and/or di

Cont

Table 3.4 (Continued)

NAR	ENTIAL HAZARD	EFFECT - PRECAUTIONARY/EVASIVE ACTION	ADVANCE INDICA INFORMATION AB
ous i asins slow Ship l and Recc t be	thwesterly ves - Occurs fol- rontal passage n backside of y lows. Winds 30 s for 12 to 18 ot uncommon for 20- nds to continue for ays or as long as ins nearly station- Mediterranean. ves of 15-17 ft ccur during strong orms. Swell of 6- 3m) often persists k or more. Wave spread across a trum of es/periods. ide breakwaters o about 3-4 ft trongest winter	a. Navigation hazardous in crowded harbor. Ships buoy-moored in basins may swing into narrow fairway and/or slow moving ships may be blown out of fairway. Ships entering/departing should stay to windward and only slow for pilot embark/debark action. Recommend arriving/ departing maneuvers not be executed during high wind conditions.	a. Strong northwe frontal passage and, migratory lows. The for several days whe becomes nearly stati Eastern Mediterranea general source regio Sea, Gulf of Antalya Africa south of the two areas are active April. North Africa eastward far enough area are most likely June. Strong northw preceded by strong K wind veering to sout indicates the approa passage winds become dust drops off rapid and humidity increas
to th rence and w seas wint range ighti	heasterly es - Locally known in", a regional Sirocco". Winds 35 kts may persist 4 days in advance ching N. African ns. Hot, dry, ds from deserts to igh personal , anomalous io propagation, orizontal and ge visibility, penetration all strong wind shear of inversion. ak season ril) winds may rom the SE for a days but at ss than 25 kts and num blowing dust hot and dry.	b. Problems similar to those under north-westerly winds. Differences will be ship movements and stress, and windward will be in opposite direction and season of most likely occurrence shifts from winter to spring. Radar and radio propagation ranges limited. Mirage effects cause visual sightings to be questionable.	b. Khamsin, a reg winds, are hot, dry from out of the des early spring event March and April. S associated with the depressions. North ment is likely with across Morocco. A northwest at Algier cyclogenesis east o Cumulonimbus develo northwestern Egypt, imagery, indicates Falling pressure ov easterly surface wi (61416/61417) indic the depression. Lo approach and Khamsi falling pressure, a the west, surface w easterly, rapid dec continuing to veer ing dust. The dura from less than a da in March and April. typically take an o Khamsin season, shi and over land in sp conventional data a the late season sys define and track.
harbo nd pa ticip tion	nts near ariable speed. Generally ne wind at .5 to	c. Currents near the harbor entrance vary in response to changing wind patterns. Variable conditions should be anticipated in response to wind speed and/or direction changes.	c. Variable curre pilot embark/debark runs with the wind. windward and only s

ontinued)

ARY/EVASIVE ACTION	ADVANCE INDICATORS AND OTHER INFORMATION ABOUT POTENTIAL HAZARD
s in crowded harbor. ins may swing into ow moving ships may be hips entering/departing and only slow for pilot ecommend arriving/ be executed during high	a. Strong northwesterly winds occur following frontal passage and/or on the back side of migratory lows. These wind events will persist for several days when the associated low becomes nearly stationary in the Cyprus area. Eastern Mediterranean cyclones have three general source regions: Aegean Sea/Cretan Sea, Gulf of Antalya to Cyprus, and North Africa south of the Atlas Mountains. The first two areas are active from late October through April. North African depressions that move eastward far enough to influence the Port Said area are most likely in February through early June. Strong northwesterlies are generally preceded by strong Khamsin events. Southerly wind veering to southwesterly and increasing indicates the approach of the front and with passage winds become northwesterly, blowing dust drops off rapidly, temperature drops off and humidity increases.
those under north- nces will be ship d windward will be in eason of most likely inter to spring. Radar nges limited. Mirage ntings to be question-	b. Khamsin, a regional name for Sirocco type winds, are hot, dry and dusty southerly flow from out of the desert. They are a late winter early spring event and are most intense in March and April. Strong Khamsin events are associated with the approach of north African depressions. North African depression development is likely with strong surface ridging across Morocco. A wind shift from southwest to northwest at Algier (60390) is an indicator of cyclogenesis east of the Atlas mountains. Cumulonimbus development over Libya and northwestern Egypt, evident in satellite imagery, indicates depression development. Falling pressure over this same area and/or an easterly surface wind report from SIWA (61416/61417) indicates eastward movement of the depression. Local indicators of depression approach and Khamsin development include: falling pressure, approach of high cirrus from the west, surface winds veering from north to easterly, rapid decrease in humidity, winds continuing to veer to south, and onset of blowing dust. The duration increases on average from less than a day in February to 2 to 3 days in March and April. These depressions/cyclones typically take an overwater track early in the Khamsin season, shifting southward to coastal and over land in spring. Due to lack of conventional data and classic cloud development the late season systems are more difficult to define and track.
rbor entrance vary in patterns. Variable cipated in response to on changes.	c. Variable currents near entrance in area of pilot embark/debark action. Current normally runs with the wind. Ships should stay to windward and only slow for pilot.

Table 3.4 (Cont

VESSEL LOCATION/ SITUATION	POTENTIAL HAZARD	EFFECT - PRECAUTION
4. <u>Small Boat Operations</u> Strongest in winter occurs in Spring and Autumn	a. <u>Northwesterly Winds/Waves</u> - Occurs following frontal passage and/or on backside of migratory lows. Winds 30 to 40 kts for 12 to 18 hours, not uncommon for 20-30 kt winds to continue for 2 or 3 days or as long as low remains nearly stationary in NE Mediterranean. Swell waves of 15-17 ft (5m) - occur during strong winter storms. Swell of 6-10 ft (2-3m) often persists for a week or more. Wave energy is spread across a wide spectrum of frequencies/periods. Waves inside breakwaters limited to about 3-4 ft (1m) in strongest winter storms.	a. Small boat operation anchorages will be cancel weather. Under typical s Mediterranean northwester conditions, operations ou hazardous. Spread of wave range of periods causes a alongside operations. S should be to lee side to tection. Summertime sea prevailing northerly wind conditions outside harbor
Occurs February through early June most intense and longest duration March and April	b. <u>Southeasterly Winds/Waves</u> - Locally known as "Khamsin", a regional form of "Sirocco". Winds of 25 to 35 kts may persist for 3 to 4 days in advance of approaching N. African depressions. Hot, dry, dusty winds from deserts to south. High personal discomfort, anomalous radar/radio propagation, reduced horizontal and slant range visibility, fine dust penetration all systems, strong wind shear near top of inversion. During peak season (March/April) winds may persist from the SE for a number of days but at speeds less than 25 kts and with minimum blowing dust but still hot and dry.	b. Minimal wave heights Blowing dust/sand and red create hazards. During l Khamsin events sea breeze offshore wind providing n during afternoon.

Table 3.4 (Continued)

TIAL HAZARD	EFFECT - PRECAUTIONARY/EVASIVE ACTION	ADVANCE INDICATORS INFORMATION ABOUT
westerly es - Occurs fol- ntal passage backside of lows. Winds 30 for 12 to 18 uncommon for 20- ls to continue for rs or as long as is nearly station- Mediterranean. es of 15-17 ft cur during strong orms. Swell of 6- 3m) often persists or more. Wave spread across a trum of es/periods. de breakwaters about 3-4 ft trongest winter	a. Small boat operations to/from outer anchorages will be canceled during stormy weather. Under typical southeastern Mediterranean northwesterly wind and wave conditions, operations outside harbor are hazardous. Spread of wave energy across wide range of periods causes additional hazards for alongside operations. Small boat rigging should be to lee side to provide maximum protection. Summertime sea breeze will enhance prevailing northerly winds resulting in choppy conditions outside harbor.	a. Strong northwesterly frontal passage and/or on migratory lows. These wi for several days when the becomes nearly stationary Eastern Mediterranean cyc general source regions: Sea, Gulf of Antalya to C Africa south of the Atlas two areas are active from April. North African dep eastward far enough to in area are most likely in F June. Strong northwester preceded by strong Khamsi wind veering to southwest indicates the approach of passage winds become nort dust drops off rapidly, t and humidity increases.
neasterly es - Locally known n", a regional sirocco". Winds 5 kts may persist days in advance hing N. African s. Hot, dry, s from deserts to gh personal , anomalous o propagation, rizontal and e visibility, penetration all trong wind shear f inversion. k season il) winds may om the SE for a days but at s than 25 kts and m blowing dust hot and dry.	b. Minimal wave heights with offshore flow. Blowing dust/sand and reduced visibility will create hazards. During light to moderate Khamsin events sea breeze may nearly cancel out offshore wind providing near calm conditions during afternoon.	b. Khamsin, a regional r winds, are hot, dry and du from out of the desert. T early spring event and are March and April. Strong K associated with the approa depressions. North Africa ment is likely with strong across Morocco. A wind sh northwest at Algier (6039(cyclogenesis east of the A Cumulonimbus development c northwestern Egypt, eviden imagery, indicates depress Falling pressure over this easterly surface wind repo (61416/61417) indicates ea the depression. Local ind approach and Khamsin devel falling pressure, approach the west, surface winds ve easterly, rapid decrease i continuing to veer to sout ing dust. The duration in from less than a day in Fe in March and April. These typically take an overwate Khamsin season, shifting s and over land in spring. conventional data and clas the late season systems ar define and track.

tinued)

ARY/EVASIVE ACTION	ADVANCE INDICATORS AND OTHER INFORMATION ABOUT POTENTIAL HAZARD
s to/from outter ed during stormy outheastern ly wind and wave tside harbor are energy across wide dditional hazards for mall boat rigging provide maximum pro- breeze will enhance s resulting in choppy .	a. Strong northwesterly winds occur following frontal passage and/or on the back side of migratory lows. These wind events will persist for several days when the associated low becomes nearly stationary in the Cyprus area. Eastern Mediterranean cyclones have three general source regions: Aegean Sea/Cretan Sea, Gulf of Antalya to Cyprus, and North Africa south of the Atlas Mountains. The first two areas are active from late October through April. North African depressions that move eastward far enough to influence the Port Said area are most likely in February through early June. Strong northwesterlies are generally preceded by strong Khamsin events. Southerly wind veering to southwesterly and increasing indicates the approach of the front and with passage winds become northwesterly, blowing dust drops off rapidly, temperature drops off and humidity increases.
with offshore flow. uced visibility will ight to moderate may nearly cancel out ear calm conditions	b. Khamsin, a regional name for Sirocco type winds, are hot, dry and dusty southerly flow from out of the desert. They are a late winter early spring event and are most intense in March and April. Strong Khamsin events are associated with the approach of north African depressions. North African depression development is likely with strong surface ridging across Morocco. A wind shift from southwest to northwest at Algier (60390) is an indicator of cyclogenesis east of the Atlas mountains. Cumulonimbus development over Libya and northwestern Egypt, evident in satellite imagery, indicates depression development. Falling pressure over this same area and/or an easterly surface wind report from SIWA (61416/61417) indicates eastward movement of the depression. Local indicators of depression approach and Khamsin development include: falling pressure, approach of high cirrus from the west, surface winds veering from north to easterly, rapid decrease in humidity, winds continuing to veer to south, and onset of blowing dust. The duration increases on average from less than a day in February to 2 to 3 days in March and April. These depressions/cyclones typically take an overwater track early in the Khamsin season, shifting southward to coastal and over land in spring. Due to lack of conventional data and classic cloud development the late season systems are more difficult to define and track.

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PORT VISIT INFORMATION

January 1989. NOARL meteorologists R. Fett and D. Perryman met with U.S. Navy husbanding agent Abdou S. El Lamei to obtain much of the information used in this port evaluation.

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* Formerly the Naval Environmental Prediction Research Facility

APPENDIX A

General Purpose Oceanographic Information

This section provides general information on wave forecasting and wave climatology as used in this study. The forecasting material is not harbor specific. The material in paragraphs A.1 and A.2 was extracted from H.O. Pub. No. 603, Practical Methods for Observing and Forecasting Ocean Waves (Pierson, Neumann, and James, 1955). The information on fully arisen wave conditions (A.3) and wave conditions within the fetch region (A.4) is based on the JONSWAP model. This model was developed from measurements of wind wave growth over the North Sea in 1973. The JONSWAP model is considered more appropriate for an enclosed sea where residual wave activity is minimal and the onset and end of locally forced wind events occur rapidly (Thornton, 1986), and where waves are fetch limited and growing (Hasselmann, et al., 1976). Enclosed sea, rapid onset/subsiding local winds, and fetch limited waves are more representative of the Mediterranean waves and winds than the conditions of the North Atlantic from which data was used for the Pierson and Moskowitz (P-M) Spectra (Neumann and Pierson 1966). The P-M model refined the original spectra of H.O. 603, which over developed wave heights.

The primary difference in the results of the JONSWAP and P-M models is that it takes the JONSWAP model longer to reach a given height or fully developed seas. In part this reflects the different starting wave conditions. Because the propagation of waves from surrounding areas into semi-enclosed seas, bays, harbors, etc. is limited, there is little residual wave action following periods of locally light/calm winds and the sea surface is nearly flat. A local wind developed wave growth is therefore slower than wave growth in the open ocean where some residual wave action is generally always present. This slower wave development is a built in bias in the formulation of the JONSWAP model which is based on data collected in an enclosed sea.

A.1 Definitions

Waves that are being generated by local winds are called "SEA". Waves that have traveled out of the generating area are known as "SWELL". Seas are chaotic in period, height and direction while swell approaches a simple sine wave pattern as its distance from the generating area increases. An in-between state exists for a few hundred miles outside the generating area and is a condition that reflects parts of both of the above definitions. In the Mediterranean area, because its fetches and open sea expanses are limited, SEA or IN-BETWEEN conditions will prevail. The "SIGNIFICANT WAVE HEIGHT" is defined as the average value of the heights of the one-third highest waves. PERIOD and WAVE LENGTH refer to the time between passage of, and distances between, two successive crests on the sea surface. The FREQUENCY is the reciprocal of the period ($f = 1/T$) therefore as the period increases the frequency decreases. Waves result from the transfer of energy from the wind to the sea surface. The area over which the wind blows is known as the FETCH, and the length of time that the wind has blown is the DURATION. The characteristics of waves (height, length, and period) depend on the duration, fetch, and velocity of the wind. There is a continuous generation of small short waves from the time the wind starts until it stops. With continual transfer of energy from the wind to the sea surface the waves grow with the older waves leading the growth and spreading the energy over a greater range of frequencies. Throughout the growth cycle a SPECTRUM of ocean waves is being developed.

A.2 Wave Spectrum

Wave characteristics are best described by means of their range of frequencies and directions or their spectrum and the shape of the spectrum. If the spectrum of the waves covers a wide range of frequencies and directions (known as short-crested conditions), SEA conditions prevail. If the spectrum covers a narrow range of frequencies and directions (long crested conditions), SWELL conditions prevail. The wave spectrum depends on the duration of the wind, length of the fetch, and on the wind velocity. At a given wind speed and given state of wave development, each spectrum has a band of frequencies where most of the total energy is concentrated. As the wind speed increases the range of significant frequencies extends more and more toward lower frequencies (longer periods). The frequency of maximum energy is given in equation 1.1 where v is the wind speed in knots.

$$f_{max} = \frac{2.476}{v} \qquad (1.1)$$

The wave energy, being a function of height squared, increases rapidly as the wind speed increases and the maximum energy band shifts to lower frequencies. This results in the new developing smaller waves (higher frequencies) becoming less significant in the energy spectrum as well as to the observer. As larger waves develop an observer will pay less and less attention to the small waves. At the low frequency (high period) end the energy drops off rapidly, the longest waves are relatively low and extremely flat, and therefore also masked by the high energy frequencies. The result is that 5% of the upper frequencies and 3% of the lower frequencies can be cut-off and only the remaining frequencies are considered as the "significant part of the wave spectrum". The resulting range of significant frequencies or periods are used in defining a fully arisen sea. For a fully arisen sea the approximate average period for a given wind speed can be determined from equation (1.2).

$$\bar{T} = 0.285v \tag{1.2}$$

Where v is wind speed in knots and $\bar{T}$ is period in seconds. The approximate average wave length in a fully arisen sea is given by equation (1.3).

$$\bar{L} = 3.41\,\bar{T}^2 \tag{1.3}$$

Where $\bar{L}$ is average wave length in feet and $\bar{T}$ is average period in seconds.

The approximate average wave length of a fully arisen sea can also be expressed as:

$$\bar{L} = .67\text{"L"} \tag{1.4}$$

where "L" = $5.12T^2$, the wave length for the classic sine wave.

A.3 Fully Arisen Sea Conditions

For each wind speed there are minimum fetch (n mi) and duration (hr) values required for a fully arisen sea to exist. Table A-1 lists minimum fetch and duration values for selected wind speeds, values of significant wave (average of the highest 1/3 waves) period and height, and wave length of the average wave during developing and fully arisen seas. The minimum duration time assumes a start from a flat sea. When pre-existing lower waves exist the time to fetch limited height will be shorter. Therefore the table duration time represents the maximum duration required.

Table A-1. Fully Arisen Deep Water Sea Conditions Based on the JONSWAP Model.

Wind Speed (kt)	Minimum Fetch/Duration (n mi) (hrs)	Sig Wave (H1/3 Period/Height (sec) (ft)	Wave Length (ft)[1,2] Developing/Fully /Arisen L X (.5) /L X (.67)
10	28 / 4	4 / 2	41 / 55
15	55 / 6	6 / 4	92 / 123
20	110 / 8	8 / 8	164 / 220
25	160 / 11	9 / 12	208 / 278
30	210 / 13	11 / 16	310 / 415
35	310 / 15	13 / 22	433 / 580
40	410 / 17	15 / 30	576 / 772

NOTES:

[1] Depth throughout fetch and travel zone must be greater than 1/2 the wave length, otherwise shoaling and refraction take place and the deep water characteristics of waves are modified.

[2] For the classic sine wave the wave length (L) equals 5.12 times the period (T) squared ($L = 5.12T^2$). As waves develop and mature to fully developed waves and then propagate out of the fetch area as swell there wave lengths approach the classic sine wave length. Therefore the wave lengths of developing waves are less than those of fully developed waves which in turn are less than the length of the resulting swell. The factor of .5 (developing) and .67 (fully developed) reflect this relationship.

A.4 <u>Wave Conditions Within The Fetch Region</u>

Waves produced by local winds are referred to as <u>SEA</u>. In harbors the local sea or wind waves may create hazardous conditions for certain operations. Generally within harbors the fetch lengths will be short and therefore the growth of local wind waves will be fetch limited. This implies that there are locally determined upper limits of wave height and period for each wind velocity. Significant changes in speed or direction will result in generation of a new wave group with a new set of height and period limits. Once a fetch limited sea reaches its upper limits no further growth will occur unless the wind speed increases.

Table A-2 provides upper limits of period and height for given wind speeds over some selected fetch lengths. The duration in hours required to reach these upper limits (assuming a start from calm and flat sea conditions) is also provided for each combination of fetch length and wind speed. Some possible uses of Table A-2 information are:

1) If the only waves in the area are locally generated wind waves, the Table can be used to forecast the upper limit of sea conditions for combinations of given wind speeds and fetch length.

2) If deep water swell is influencing the local area in addition to locally generated wind waves, then the Table can be used to determine the wind waves that will combine with the swell. Shallow water swell conditions are influenced by local bathymetry (refraction and shoaling) and will be addressed in each specific harbor study.

3) Given a wind speed over a known fetch length the maximum significant wave conditions and time needed to reach this condition can be determined.

Table A-2. Fetch Limited Wind Wave Conditions and Time Required to Reach These Limits (Based on JONSWAP Model). Enter the table with wind speed and fetch length to determine the significant wave height and period, and time duration needed for wind waves to reach these limiting factors. All of the fetch/speed combinations are fetch limited except the 100 n mi fetch and 18 kt speed.

Format: height (feet)/period (seconds)
duration required (hours)

Fetch Length (n mi) \ Wind Speed (kt)	18	24	30	36	42
10	2/3-4 1-2	3/3-4 2	3-4/4 2	4/4-5 1-2	5/5 1-2
20	3/4-5 2-3	4/4-5 3	5/5 3	6/5-6 3-4	7/5-6 3
30	3-4/5 3	5/5-6 4	6/6 3-4	7/6 3-4	8/6-7 3
40	4-5/5-6 4-5	5/6 4	6-7/6-7 4	8/7 4	9-10/7-8 3-4
100	5/6-7[1] 5-6	9/8 8	11/9 7	13/9 7	15-16/9-10 7

[1] 18 kt winds are not fetch limited over a 100 n mi fetch.

An example of expected wave conditions based on Table A-2 follows:

WIND FORECAST OR CONDITION

An offshore wind of about 24 kt with a fetch limit of 20 n mi (ship is 20 n mi from the coast) is forecast or has been occurring.

SEA FORECAST OR CONDITION

From Table A-2: If the wind condition is forecast to last, or has been occurring, for at least 3 hours:

Expect sea conditions of 4 feet at 4-5 second period to develop or exist. If the condition lasts less than 3 hours the seas will be lower. If the condition lasts beyond 3 hours the sea will not grow beyond that developed at the end of about 3 hours unless there is an increase in wind speed or a change in the direction that results in a longer fetch.

A.5 Wave Climatology

The wave climatology used in these harbor studies is based on 11 years of Mediterranean SOWM output. The MED-SOWM is discussed in Volume II of the U.S. Naval Oceanography Command Numerical Environmental Products Manual (1986). A deep water MED-SOWM grid point was selected as representative of the deep water wave conditions outside each harbor. The deep water waves were then propagated into the shallow water areas. Using linear wave theory and wave refraction computations the shallow water climatology was derived from the modified deep water wave conditions. This climatology does not include the local wind generated seas. This omission, by design, is accounted for by removing all wave data for periods less than 6 seconds in the climatology. These shorter period waves are typically dominated by locally generated wind waves.

A.6 Propagation of Deep Water Swell Into Shallow Water Areas

When deep water swell moves into shallow water the wave patterns are modified, i.e., the wave heights and directions typically change, but the wave period remains constant. Several changes may take place including shoaling as the wave feels the ocean bottom, refraction as the wave crest adjusts to the bathymetry pattern, changing so that the crest becomes more parallel to the bathymetry contours, friction with the bottom sediments, interaction with currents, and adjustments caused by water temperature gradients. In this work, only shoaling and refraction effects are considered. Consideration of the other factors are beyond the resources available for this study and, furthermore, they are considered less significant in the harbors of this study than the refraction and shoaling factors.

To determine the conditions of the deep water waves in the shallow water areas the deep water conditions were first obtained from the Navy's operational MED-SOWM wave model. The bathymetry for the harbor/area of interest was extracted from available charts and digitized for computer use. Figure A-1 is a sample plot of bathymetry as used in this project. A ray path refraction/shoaling program was run for selected combinations of deep water wave direction and period. The selection was based on the near deep water wave climatology and harbor exposure. Each study area requires a number of ray path computations. Typically there are 3 or 4 directions (at 30° increments) and 5 or 6 periods (at 2 second intervals) of concern for each area of study. This results in 15 to 24 plots per area/harbor. To reduce this to a manageable format for quick reference, specific locations within each study area were selected and the information was summarized and is presented in the specific harbor studies in tabular form.

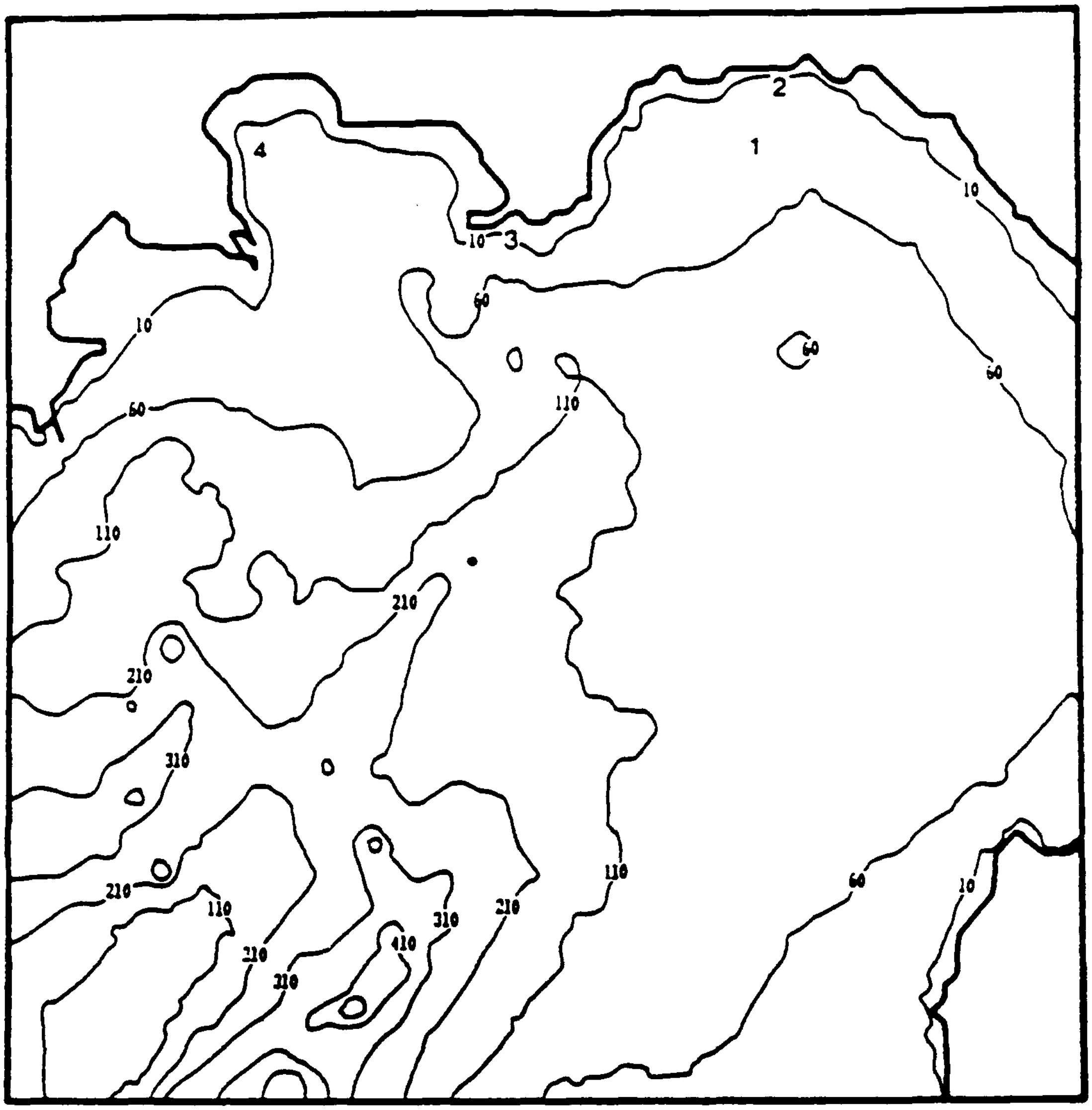

Figure A-1. Example plot of bathymetry (Naples harbor) as used in this project. For plotting purposes only, contours are at 50 fathom intervals from an initial 10 fathom contour. The larger size numbers identify specific anchorage areas addressed in the harbor study.

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31M1	Tank Landing Ship LANT
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32C1	Ammunition Ship LANT
32G1	Combat Store Ship LANT
32H1	Fast Combat Support Ship LANT
32N1	Oiler LANT
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32S1	Repair Ship LANT
32X1	Salvage Ship LANT

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This handbook for the port of Port Said, one in a series of severe weather guides for Mediterranean ports, provides decision-making guidance for ship captains whose vessels are threatened by actual or forecast strong winds, high seas, restricted visibility or thunderstorms in the port vicinity. Causes and effects of such hazardous conditions are discussed. Precautionary or evasive actions are suggested for various vessel situations. The handbook is organized in four sections for ready reference: general guidance on handbook content and use; a quick-look captain's summary; a more detailed review of general information on environmental conditions; and an appendix that provides oceanographic information.

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